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JPRS-CEA-85-083

17 September 1985

China Report

ECONOMIC AFFAIRS

ENERGY: STATUS AND DEVELOPMENT--42

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CHINA REPORT

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CONTENTS

NATIONAL POLICY

NATION'S ENERGY REQUIREMENTS TO YEAR 2000 EXPLORED

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF DIALECTICS OF NATURE] in Chinese No 2, 10 Apr 85 pp 23-29

[Article by Zhu Bin [2612 2430]: "Exploring China's Energy Resources of the Future"]

[Text] Two great changes may occur in China's energy resources between now and the end of the century. One is a numerical increase, with annual consumption increasing from the present figure of 600 million tons of standard coal to more than 1.2 billion tons. Of this amount, raw coal may surpass the Soviet Union and America and reach first place worldwide. The second is structural changes, with the appearance of nuclear energy, which may account for 1 percent of the consumption structure. Time restrictions do not permit China to hope for an energy resource miracle over the next 10-plus years. Research on the historical evolution of energy resources must be carried out over an even longer period. More than a century ago, the shortage of firewood in Europe caused coal to increase from less than 20 percent of the energy resources market to 50 percent, and took more than 50 years. In the United States, it has taken roughly 50 to 60 years for a new energy resource to corner the market. This perspective considers only markets. If we add the many technical and social restricting factors, historical changes in energy resources may require even longer periods. For this reason, development of energy resources in China over the next 15 years is only the starting point of even longer term changes. Our goal demands an excellent starting point.

I. There Is no Single Goal

If we look from the perspective of human activity, energy resources are a truly complex system. In the minimum sense, they are closely interrelated with the economy, the environment and patterns of human life. There should not be a single future goal for energy resources. We should strive for a comprehensive and rational goal in consideration of all the many economic and environmental factors. China must quadruple the total value of industrial and agricultural output by the end of this century. What demands does this economic goal place on future energy resources? The high standard is based on an identical rate of

growth for energy resources and the economy. The energy elasticity coefficient is 1 and yearly energy resource output will increase from 600 million tons of standard coal to 2.4 billion tons. The low standard is to double [energy resource output], with an energy elasticity coefficient of 0.5, an increase from 600 million tons of standard coal to 1.2 billion tons. The use of a multiple prediction method can provide forecasts of China's energy resources up to the end of the century. The value usually is between 1.2 and 2.4 billion tons. Two groups of forecast data are provided here. One group, from Qinghua University is based on the energy resource elasticity coefficient (derived) as shown in Table 1. The other group was derived by the World Bank on the basis of the ultimate energy resource consumer (Table 2). The many factors assumed in the forecasts make it unnecessary to determine which forecast is accurate. The most rational of the forecasts, however, will be pointed out. That is to say, it requires that our estimates not only consider the need for economic growth and the possibility of the development of energy systems themselves, but also requires a consideration of environmental protection, social life and other factors.

Table 1. Forecast Demand for Energy Resources in China to 2000

Program	Energy Requirements (100 million tons standard coal/year)		
	1985	1990	2000
I	7.14	8.86	14.36
II	7.39	9.40	16.06
III	7.00	9.53	17.14

Table 2. Predicted Consumption of Commodity Energy Resources in China

	Low Estimate		High Estimate	
	1990	2000	1990	2000
Agriculture	0.29	0.41	0.37	0.60
Communications	0.58	1.11	0.66	1.43
Household/commercial use	1.57	1.99	2.05	3.44
Industry	5.24	9.20	5.85	11.64
Other	0.20	0.32	0.24	0.45
Total end consumption	7.88	13.03	9.17	17.56

Units: 100 million tons of standard coal

During research on the establishment of a model long-term global energy resource strategy, the Vienna International Applied Systems Analysis Research Institute (IIASA) has stipulated clearly several goals for a model energy resource strategy that calls for an ability in future energy resource systems to contain economic, environmental and social factors. Energy is not lost after it has been consumed but produces waste heat, carbon dioxide and other pollutants. The consumption of energy resources requires the consumption of raw materials, manpower, land, and water. Energy also has many influences on society. Most research work on energy resources at present stops after the formulation of an optimum strategy. A further consideration of the effects of energy resources on society after they are consumed is needed now.

With integration with the experiences of foreign countries, what factors should be considered when establishing China's energy resource system of the future? There are at least several factors: demand for energy resources from economic growth, including absolute amounts of energy resource supplies and rate of increase; an evaluation of energy resources, which depends on the ability of a nation to develop energy resources on the basis of its own energy resources; trends in the world energy trade, especially the effects of international markets on China's energy resources; the existing technical foundations and potential for technical innovation; the need for environmental protection; and finally, other important social questions related to energy resources such as radioactive pollution, nuclear dispersion, improvement of the people's standard of living and so on. A foreign research project feels that energy resource consumption may double and that the people's standard of living may double. There is, however, no such linear relationship between growth in the total value of national output and improvement of the people's standard of living.

II. Analysis of Measures and Prospects

1. Development rates and principles

There are three possible rates of development of China's economy up to the end of the century: a high rate, moderate rate and slow rate. The first is a high rate of growth exceeding 8 percent. The second is around 5 percent. The third is below 3 percent. Like economic development, there are three optimum programs for the level of development of energy resources that can be selected. The first program is to increase from the current 600 million tons of raw coal per year to 2.4 billion tons by the year 2000, a four-fold increase. The second program is to increase to 1.2 billion tons. The third is a production figure of less than 1 billion tons by the year 2000. The government now has selected the second program for producing energy resources of 1.2 billion tons of standard coal by the year 2000. Of this amount, coal will increase from 600 million tons to 1.2 billion tons, while petroleum will increase from 100 million tons to 230 million tons. The average annual growth rate for energy resources is 3.5 percent, an absolute increase of 3 million tons. Table 3 illustrates three energy resource production programs for China. The most optimum of them is a qualitative selection based on a consideration of environmental influences. China will be unable to establish strategic energy resource reserves within the next ten-plus years since energy resource production and consumption basically will be balanced. For this reason, the energy resource production index and consumption index are identical.

Table 3. Several Programs for Energy Resource Production in China to the Year 2000

units: 100 million tons of standard coal

		Program 1	Program 2	Program 3	Government plans	Optimum program
Total production	Absolute amount	24.00	12.00	10.00	12.00	12.00
	Percentage	100	100	100	100	100
Coal	Absolute amount	17.00	8.20	7.00	8.50	7.20
	Percentage	70.8	68.3	70.0	70.8	60.0
Petroleum	Absolute amount	5.72	2.86	2.30	3.20	3.60
	Percentage	23.8	23.8	23.0	20.6	30.0
Natural gas	Absolute amount	0.60	0.40	0.30		0.48
	Percentage	2.5	3.3	3.0		4.0
Hydropower	Absolute amount	0.58	0.42	0.30		0.60
	Percentage	2.4	3.5	3.0		5.0
Nuclear power	Absolute amount	0.10	0.12	0.10		0.12
	Percentage	0.5	1.0	1.0		1.0

The principles and rates are coexistent. China's overall principles of energy resource development over a number of years into the future can be outlined as follows:

In the relationship between energy resource development and energy resource consumption, implement a policy of combined energy conservation and development, with a focus on energy conservation over the next few years (the next four or five years).

In the development and utilization of multiple types of conventional energy resources, adhere to the principle of coal as the primary energy resource. This principle does not abandon the development of petroleum and includes development of off-shore petroleum. We should strive to maintain petroleum production at the 100 million tons per year level.

Strive to develop electrical power and implement a policy of combining hydroelectric and thermal power in the short term with a focus on thermal power and a gradual transition to hydroelectric power.

In the area of developing energy resources, after a long period of fluctuation, we have begun to develop nuclear power stations as a supplement to electrical power. Other new energy resources like solar energy, geothermal energy, tidal energy and so on also receive a certain amount of attention but do not occupy a [significant] status in the energy resource consumption structure.

Are these principles everlasting? It depends on whether or not they are adapted to China's national conditions, the understanding that those in power have of the objective world and other factors. China does, however, need a stable energy resource development policy. The task of those in power is to discern and foresee unstable factors and to eliminate hidden dangers.

There are two main factors related to instability in the principle of energy conservation. One is that many people in China, especially administrative cadres, view the principle of energy conservation as a temporary policy. The reason is that China has not been able to obtain real benefits from energy resource development over the past 4 or 5 years and that it has been forced to implement a principle of energy resource conservation in order to provide the energy resources needed by growth of the national economy over the past few years. The second factor is that the potential for energy conservation will shrink as time passes. There was no substantial degree of increase in estimated consumption of energy resources in China over the past decade and absolute amounts of energy conserved will drop in comparison with the present. Energy resource circles in China have disputed the potential for energy conservation over the past several years and there is no accurate estimate of the potential for energy conservation in China even today. Of course, quantitative calculations of the potential for energy conservation are very difficult both in terms of fact and method.

It should be noted that the principle of energy conservation is a positive economic principle. The world's population is growing daily and consumption of all types of materials is growing daily as well.

There is data that indicates that global resources including petroleum, coal, metals, and others will be consumed at unprecedented rates and quantities over the next 20 to 30 years. This phenomenon is a disaster for the future of humanity. Many nations have implemented policies for resource protection that no doubt are farsighted decisions. If a country is concerned only with immediate or short-term benefits and goes all-out to develop its resources, unrecoverable losses will be inevitable. A policy without long-term benefits is not a correct policy. The method that can be chosen is appropriate and moderate development of a nation's resources based on growth of the national economy and the need to improve the people's standard of living. Since its founding in 1776, the United States has developed its territorial resources in a limited manner. It has abundant underground coal, second in the world, but the government has never formulated a special policy to encourage the development of coal. Coal accounts for about 22 percent of energy resource consumption in the United States. China is a nation with a long history, but it is backward. Two characteristics in energy resource development have been formed over a long period: excessive development of above-ground resources (forests, grasslands, soil, etc.) that has

led to a serious loss of equilibrium in soil erosion in the Huang He basin and a failure to develop a large part of its underground resources (coal, metals, etc.) that have become precious wealth in modernization and construction in today's China. We cannot, however, be immoderate in developing this underground treasurehouse by falling into the same mistaken path.

We will discuss again the principle of making coal the focus. China has rich coal reserves and a long history of applied technology, and they will continue to serve as a primary energy resource. A focus on coal, however, has another meaning, which is that development of coal will be the focus of future development of energy resources. Is this policy a stable one? Like many other nations of the world, petroleum has been able and has actually shaken coal's position as the primary energy resource. This happened in China during the 1960's, during which time the country set up many petroleum using facilities. Will this play appear again in China in the future? Will the leading actor on the energy resource stage change again? There is a possibility. Originally, India concentrated on development of coal, but the penetration of petroleum during the late 1950's caused India to import large amounts of cheap petroleum. Petroleum consumption quickly rose as a part of India's energy consumption. Later, the high costs of petroleum imports caused the Indian Government to change its policies and strive to develop the nation's rich coal resource, with obvious results. Not long afterward, however, India discovered a large amount of petroleum offshore, and the policy of developing coal was shaken again. This is an example that can be borrowed.

2. Estimating investments

Whether or not sufficient investments can be provided is a key question that is related to China's energy resource construction in the future. Saying that the structural components in future energy resource projects are determined by energy resources is not the same as saying that they are determined by energy resource investments. The investment situation will determine the scale of nuclear power plant development in China and also will decide the development prospects for offshore petroleum in China.

During the 5 years between 1978 and 1982, investments in energy resources in China accounted for 2.1 percent (1978), 1.7 percent (1979), 1.7 percent (1980), 1.3 percent (1981), and 1.2 percent (1982) of the total value of industrial and agricultural output, respectively. This level is lower than in the developed nations. Investments in energy resources in the developed nations in 1975 accounted for 2 percent of Gross Domestic Product (GDP). An examination of developmental trends indicates that the proportion in energy resource investments will continue to rise, and will rise to around 4 percent in the developed nations after 2000. The figure will be slightly larger in the developing nations. It deserves mention that, if investments in energy resources reach 4.5 percent of GDP, they will be exactly equal to the proportion of world military expenditures at present. This situation tells us that, although energy resource investments in China have assumed first place in capital construction nationwide, accounting for almost one-fourth, the burden already is heavy enough. As for future demand for energy resources, however, investments on this scale still will be inadequate.

We are providing three investment standards: a low standard, in which energy resource investments account for 2 percent of the total value of industrial and agricultural output; a medium standard, at 4 percent; and a high standard at 6 percent. If we assume that there will be a sustained 7 percent rate of growth in the total value of industrial and agricultural output beginning in 1981, then the total value of industrial and agricultural output will reach 2.802 trillion yuan in the year 2000, which is a quadrupled level. This permits us to calculate total investments in energy resources between 1986 and 2000. The high standard is 1.6386 trillion yuan, the middle standard is 1.0921 trillion yuan, and the low standard is 546.2 billion yuan.

Strictly speaking, the total amount of energy resource investments over the next 15 years should be correct. We can assume the low standard of 546.2 billion yuan. This investment figure can run and build many large scale energy resource systems. We can derive some realistic outlines by adopting the group of investment expenses provided by the IIASA. It can be seen in Table 4 that the investments in nuclear power greatly exceed those in thermal and hydroelectric power, the difference being almost two times that of thermal power. If China builds 10 nuclear power plants by the end of this century with a total installed capacity of 10,000 MW, then the investments for nuclear power will be $7 billion to $9.2 billion, equivalent to 21 to 27.6 billion yuan, which is more than 4 percent of total future investments in energy resources. In another example, investments of around $35 billion will be required to reach a daily production of 3.5 million barrels of crude oil in the South China Sea oil field in the year 2000, equivalent to 105 billion yuan renminbi, which is nearly 20 percent of total investments in energy resources over the 15-year period.

We must open up routes to financing to overcome problems of insufficient capital. One method is to requisition investments for energy resource construction from local governments and enterprise departments. Another method is to expand the importation of foreign investments. The latter method could saddle China with a substantial international debt burden by the end of the century. Debt itself cannot be feared, but what is important is that we estimate correctly our ability to repay it.

3. The potential for energy conservation

China now is consuming around 600 million tons of standard coal in commodity energy resources, more than 60 percent of it used in industrial departments. A research project carried out a few years ago in the Chinese Academy of Sciences Energy Resources Research Institute shows that China's utilization efficiency for energy resources in 1978 was 30 percent. After supplementation and correction, the current national energy resource utilization efficiency is 26 percent. Energy resource utilization efficiency in a nation is a comprehensive index for evaluating the energy resource utilization level of that nation. According to data on national energy resource utilization efficiency published in foreign countries, the figure in developed nations like Japan, the United States, West Germany, and so on is over 40 percent. This shows that China has a low utilization efficiency of energy resources, that there is serious waste, and that there is great potential for energy conservation.

Table 4. Assumed Investment Costs for Primary Energy Resource Construction

	Investment costs (in 1975 U.S. dollars/kWh)
Electricity generation	
Coal	480–500
Nuclear energy	700–920
Hydropower	620
Petroleum or natural gas	325–350
Other	
Coal gassification and liquefaction	400
Refined oil	50

China has achieved excellent results in energy conservation in recent years, conserving 23.6 million tons of standard coal in 1979, 35 million tons in 1980, 27 million tons in 1981 and 18 million tons in 1982. Total energy conservation from 1979 to 1982 was 103 million tons of standard coal, equivalent to one-sixth of national annual energy consumption at the present time. This is not a small figure. The significance of energy conservation lies not only in lowering energy consumption but also promotes technological innovation and aids in protection of resources and protection the environment of human life. By starting from the concept of improved energy resource utilization efficiency and using the following formula, we can roughly extrapolate the amount of energy conserved over the lext 18 years:

$$\Delta E = E\left(1 - \frac{\eta_1}{\eta_2}\right)$$

In the formula,

E = amount of energy resources consumed

η_1 = energy resource utilization efficiency

η_2 = energy resource utilization efficiency after improvement

If we assume that:

1. Annual energy resource consumption in China is (in million tons):

1982 - 1985	1985 - 1990	1991 - 1995	1996 - 2000
600	800	1,000	1,100

2. The absolute value of the yearly percentage increase in energy resource utilization efficiency in the future is:

1982	1983	.....	1999	2000
0.26	0.27	.....	0.43	0.44

The figure derived is 458 million tons of standard coal, while the amount of energy conserved from 1986 to 2000 is 394 million tons of standard coal. This implies that if we make great efforts to improve the utilization efficiency of energy resources from the current level of 26 percent to 44 percent by the year 2000, then we will be able to conserve a total of 400 million tons of standard coal in energy resources in the next 15 years. If we add the energy conserved through rationalization of economic structures, then the energy conservation potential would be even larger, but it is limited.

4. The prospects for offshore petroleum

In China's energy resources, petroleum has the power to compete against coal. If major changes occur in the overall situation in China's energy resource policies in the future, there is no doubt that they will occur between coal and petroleum. From the perspective of energy resource development, if we say that the energy resources required for modernization of China during this century will depend mainly on increases in coal, then China will rely on development of offshore petroleum in the next 20 years and in the first 20 years of the next century to push modernization to an unprecedented step and complete it. The basis of this conclusion is the abundant petroleum resources of China's continental shelf.

China's coastline running from the Liaodong Peninsula in the north to Beibuwan in the south extends for more than 18,000 kilometers. The continental shelf sea region covers an area of 3.54 million square kilometers. The largest is the South China Sea, which covers 1.26 million square kilometers. Chinese geologists feel that the area under the continental shelf along China's coast formerly was a sedimentary basin and that it later was uplifted and became a submarine continental shelf because of crustal activity. Such sedimentary basins often contain rich amounts of petroleum and natural gas. This brilliant opinion now is beginning to be verified by geological surveys in the region. Geological surveys covering 1 million square kilometers with a focus on petroleum and natural gas were completed by the end of 1982, and six large petroliferous basins were discovered: the Bohai Basin, the Donghai Basin, the Huanghai Basin, the Zhujiangkou Basin, the Beibuwan Basin, and Yinggehai Basin. A conservative estimate of China's offshore petroleum resources is 40 billion barrels, equivalent to 6 billion tons, which is three times Britain's North Sea oilfield reserves and equal to all of Mexico's crude oil reserves. Another estimate is that China's offshore petroleum reserves could reach 170 billion barrels, equal to 24 billion tons. Responsible people in China's Ministry of Geology and Mineral Resources feel that an estimate of China's petroleum resource reserves (offshore and continental petroleum) at 30 to 60 billion tons is reliable. These two figures tally. If China's offshore petroleum reserves exceed 20 billion tons, then there is great hope for China's energy resources in the future.

The South China Sea [Nanhai] may be China's most important region for offshore petroleum. Predicted petroleum reserves in the South China Sea may account for one-half of the total offshore petroleum reserves. In the area of the sea that traditionally is considered the South China Sea, there is an area of 800,000 square kilometers of continental shelf where the water is less than 200 meters deep. According to current surveys, most of the oil strata are between 3,000 and 4,000 meters. Development costs will be rather cheap in relative terms, perhaps one-half those in England's North Sea oil field. The water in England's North Sea oil field generally is 1,000 meters deep and the oil strata are as much as 6,000 meters deep. Development costs are equivalent to $24 per barrel. It can be seen from this that development of petroleum in the South China Sea must become an important matter in China and will become world famous.

The government of China plans to increase petroleum output from the current figure of 100 million tons to 230 million tons by the end of the century. This figure is lower than estimates of some people abroad. Where will the additional 130 million tons come from? The answer is that they mainly will come from the South China Sea oil field. The South China Sea oil field and other offshore oil fields will supply a total of 100 million tons, while the remaining 30 million tons will come from new continental oilfields.

III. Environmental Factors Are Perhaps the Most Important Restraining Factors

Many factors exist that limit the establishment of a future energy system. Examples include energy resources, investments, markets, construction periods, environmental protection, WELMM restricting factors (the demands that energy resource systems place on water, land, energy resources, materials, manpower and other conditions), levels of danger and so on. Of these restricting factors, environmental factors are perhaps the ones most deserving of attention and most important.

China has not controlled environmental pollution and there is a tendency toward further degradation. This is a social problem equal in importance to the population explosion. Energy resource activities are an important source of pollution. The effects of energy resources on the environmentare shown mainly in the following three areas:

1. The effects of CO_2 on the atmosphere. Mineral fuels occupy a governing position in energy resource consumption structures. The outcome of using mineral fuels can be increased CO_2 concentrations in the atmosphere that can lead to a rise in surface temperatures. We cannot predict accurately the effects of this type of global temperature change on human life at the present time, but this does not prevent us from making a comparison with previous changes in average global temperatures. An increase of 0.5° C in temperature is noticeable. A warming of 1° C is equivalent to the surface temperature during the later part of the last Ice Age 5,500 to 6,000 years ago. An increase of 2° to 5° C is equivalent to the temperature increase during the final interglacial period 125,000 years ago. Research also has shown that a warming of 4° C will cause melting of the continental ice cap in the southern and northern polar regions and thereby raise the level of the sea, flooding most of the coastlines of the

world. Energy resource systems already have had visible local and regional atmospheric effects, such as the 2° to 3° C higher winter temperatures usually found in cities compared with their suburbs. There is a greater amount of smog in the upper atmosphere over some cities and acid rain has appeared in some areas.

2. The effects of burning coal on life and environment. This is a special problem in China because coal is the primary energy resource used in China and direct burning methods have been adopted in many instances. The waste gas and soot produced after coal is burned seriously pollute many cities and towns in China. This is especially true during the winter, when the decentralized heat supply systems in cities added to the small civilian coal stoves used for heating cause an intense increase in the amount of atmospheric pollution, generally in excess of stipulated environmental standards. Coal use will continue to undergo a substantial increase over the next 15 years. Without a fundamental change in utilization methods, China will be consuming 1.2 billion tons of raw coal [annually] by the year 2000. This will produce 240 million tons of coal ash, 40 million tons of soot and 24 million tons of carbon dioxide. These pollutants mainly will be scattered in China's large and small cities and towns and create a frightening scene.

For this reason, arrangements for coal gassification and liquefaction technologies should be treated as a strategic task. This requires us to strive to transform the coal industry into a primary source of liquid fuel production within the shortest time possible, within the next 15 years, for instance, so that coal no longer is used mainly as a solid fuel but instead is transformed into liquid and gaseous fuels. When this problem is solved, half of China's energy resource problem can be considered solved.

3. The rural firewood shortage has seriously damaged the ecological balance. Peasants in China have used wood and crop straw as their primary fuel for life for a long time, consuming an amount equal to more than 200 million tons of standard coal each year. According to a 1980 survey, 47.7 percent of the peasant families in China have a serious shortage of firewood. The enormous shortage of energy resources in rural areas has caused the price of wood to surpass the price of grain. If this continues, destruction of forests and vegetation is inevitable, as is intensified soil erosion. The middle reaches of the Huang He have the most serious soil erosion in China, with around 1.6 billion tons of silt entering the Huang He each year.

The total area of deserts nationwide has increased from 1.8 billion mu in 1950 to 1.8 billion mu in 1979. More than 20 species of precious animals and plants across the country are in danger of imminent extinction. The shortage of fuels for household use in the rural areas of China and the environmental destruction it has caused have attracted widespread attention from foreign scholars. Some people have stated that the rural firewood shortage in the developing nations is a true energy resource crisis.

At the present time, we lack sufficient knowledge to determine the real effects of energy resources on the environment that would permit us to formulate an energy resource development program. The course of events, however, has taught

everyone that environmental factors should be placed in a primary position when developing energy resources. Petroleum and natural gas as a proportion of the energy resource structure should increase from the current figure of 24 percent to 34 percent in 2000. We also should strive to develop electrical power, including a substantial increase in hydroelectric power. This is perhaps a good development program, since it can weaken the side effects of a substantial increase in the use of coal in the future. From a world perspective, the petroleum age certainly has not come to an end, but the dawn of new energy resources has appeared and the remainder of this century may be an important period of strategic choices.

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CSO: 4013/155

ACCELERATING PRODUCTION CAPABILITY FOR POWER GENERATORS DISCUSSED

Beijing ZHONGGUO JIXIE BAO in Chinese 12 Apr 85 p 1

/Editorial: "Foster a Sense of Urgency and Responsibility; Speed Up Development of the Power Generating Equipment Industry"/

/Text/ Electricity is most important for the national economy and for the livelihood of the people. The objective laws of economics determine that electricity must precede other developments and that its development must, furthermore, rightfully lead the development of the national economy. Presently, the shortage in electric power concerns all industries (including the machine building industry) and all trades and has become a crucial obstruction to the development of our national economy. The reason for the shortage of electric power, from a macroeconomic viewpoint, is the improper proportion taken up by the electrical industry in the development of the national economy as a whole. In developed countries, the elastic coefficient of electric power (which signifies the growth rate of the electric industry compared to the growth rate of the national economy) has for a long time been larger than 1, but in China the average annual figure was only 0.74 from 1979 to 1983, and even dropped to 0.5 in 1984. If no energetic measures are taken to mend this situation, the smooth development of our national economy will be seriously affected. For this reason, the state is now giving prominence to building up electric power among such other key constructions as energy sources and transportation, so that great efforts may be expended on speeding up the development of electric power.

Development of the power industry has to be preceded by the development of the industry that provides its equipment, namely the power generating equipment. This is so because the power industry requires the speedy construction of key and mainstay enterprises; it requires the industry manufacturing power generating equipment to provide such equipment of high quality, low in consumption and in sufficient quantities. The development of the power industry, furthermore, requires the implementation of a policy of "all working together," which means that all departments and localities, where favorable conditions exist, must work toward the development of electricity. This also poses a task for all manufacturers of power generating equipment to accelerate diversification of their production, to improve quality and make efforts to increase production.

In line with the development of the power industry as a whole, China's power generating equipment industry arose from a state of nonexistence, growing from small beginnings to considerable size. Although great successes have been achieved, the development has not kept pace with the needs of the developing power industry. The most prominent contradictions are: Manufacturing capacity for large thermoelectric equipment and high tension transmission and transformer installations is inadequate, and the technological level of production is too low. For instance, the coal consumption of large thermoelectrical units of 200,000 and 300,000 kW is 10 to 15 percent higher than in foreign generating units of the same capacity, some products also being of unreliable quality. Under these circumstances, it is necessary for all enterprises manufacturing power generating equipment and for research institutes to take effective measures based on technological progress to foster a sense of urgency and responsibility, to raise production capacity and improve the technological level of production to attain a higher level of product quality. Presently operating key enterprises that manufacture power generating equipment bear an unshirkable responsibility to provide equipment for the power industry. To raise production capacity we must focus attention not only specifically on the industries that manufacture generating equipment, though admittedly important, but must also look at the nation as a whole. We must have all presently operating key enterprises take the lead in developing cooperation in a variety of forms and in instituting specialized and cooperative production. The various departments responsible and in charge of the machine building industry must all break down the sectarian outlook of the past and must overcome the overambitious ideas of "ruling everything under the sky." They must rather guide and organize the mentioned cooperation and the joining of forces.

"Unite for the manufacture of machinery, jointly work for power generation." Hard work by all of us will certainly bring about a change in the power supply and generating equipment supply situation that is currently one of China's weak links.

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CSO: 4013/131

POWER NETWORK

10,000 MEGAWATT GENERATOR A POSSIBILITY BY 1990

Beijing ZHONGGUO JIXIE BAO in Chinese 12 Apr 85 p 1

/Article: "The All-China Conference of Manufacturers of Power Generating Equipment To Plan and Make Advance Arrangements For the Seventh 5-Year Plan Pointed Out: By the Year 1990, China Will Have Comprehensive Production Capability For 10,000 Megawatt Complete Units"/

/Text/ This reporter learned from the All-China Conference of Manufacturers of Power Generating Equipment To Plan and Make Advance Arrangements for the Seventh 5-Year Plan that after further implementation of plans for technological restructuring, China will be in the position, by 1990, of having a comprehensive production capacity for complete sets of power generating equipment for 10,000 megawatts. This capacity will comprise complete equipment for large and medium units of 600,000 kW, 300,000 kW, 200,000 kW and 125,000 kW plants.

The development of China's national economy demands that development of its electric power industry proceed at a faster pace than its industrial and agricultural growth rate. However, currently the growth rate of the power industry is not in tune with the development of the national economy. The gross value of industrial and agricultural output in 1984 was 14.2 percent over that of the previous year, but the increase in the power industry was only 6.6 percent. One of the reasons affecting the growth of the power industry was the low production capacity for power generating equipment, especially the insufficient capacity for the manufacture of complete units of large-scale thermal power plants and high tension transmission and transformer equipment, aggravated by the low technological level of production. These factors inhibited the construction of our power industry.

In order to provide impetus to the development of the power equipment industry, especially to achieve considerable progress during the period of the Seventh 5-Year Plan, an All-China Conference of Manufacturers of Power Generating Equipment To Plan and Make Advance Arrangements for the Seventh 5-Year Plan was convened from 1 to 8 April jointly by the State Planning Commission, the State Economic Commission, the Defense Science and Industry Commission, the Ministry of Machine Building Industry, the Ministry of Water Resources and Electric Power and the Office of Major Technological Equipment in the State Council. Representatives from over 250 units, from the machine building and industrial departments and bureaus of the various provinces, autonomous regions,

directly administered municipalities, from the electric power administrative bureaus of the various localities, from the shipbuilding and elctronics industries, from the railways, hydroelectric and machine building enterprises, all jointly deliberated on a major program for the development of the power generating equipment industry. Chairman of the State Economic Commission Lu Dong /0712 2639/, chaired the conference and also gave a speech. Minister of Machine Building Industry Zhou Jiannan /0719 1696 0589/, Deputy Minister of Water Resources and Electric Power Zhang Fengxiang /1728 7364 4382/ attended the conference and gave speeches. Vice Premier Li Peng listened to all presentations and gave an important report on 8 April to the entire body of representatives (published separately).

In compliance with the demands of the leading comrades of the CPC Central Committee and the State Council, the conference put further measures into effect for the technological restructuring of enterprises and, as to production capacity for power generating equipment by the year 1990 and short-term programming, they made workable arrangements according to the demands for complete units. The representatives expressed the opinion that they would follow the dispositions of the state plan and certainly exert great efforts to increase capacities for the production of power generating equipment and to provide the power plants with equipment as per plan, thus effecting as soon as possible a change in the current passive situation of slow developments in China's power industry.

The major measures discussed at the conference for the development of the power generating equipment industry were:

Getting organized, breaking down departmental and territorial barriers, developing specialization of production and large-scale cooperation.

Technological restructuring of present enterprises, and in the course of restructuring, above all seizing on weak links and promoting expansion of production capacity as well as raising the technological level of production.

Utilizing the excellent situation of China's opening up to the outside world and effectively importing technologies and after importation concentrating on assimilating the imported technologies.

Stabilizing our policy of providing technological equipment in a relative manner. During the period of the Seventh 5-Year Plan we shall give prioirty to thermal power plants of 200,000 and 300,000 kW units, in the case of transmission eqipment to 220,000 volt and 500,000 volt equipment, in order to proceed with lot productions in a stable manner.

Upholding the policy of giving primary consideration to quality, continuing efforts to raise the quality of products, establishing and perfecting systems of guaranteeing quality; production enterprises must make every effort to save material labor and live labor and to reduce costs.

The present conference also studied concrete measures to ensure putting 5 million kilowatt engineering projects and corresponding transmission and transformer equipment into operation this year.

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CSO: 4013/131

POWER NETWORK

SURVEY OF INSTABILITY INCIDENTS IN POWER SYSTEMS 1982-1984

Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 5, 5 Jun 85 pp 2-4, 21

[Article by Meng Dingzhong [5536 1353 0022] of the Electricity Production Department of the Ministry of Water Resources and Electric Power: "Analysis of Destabilizing Accidents in Power Grids, 1982-1984"]

[Text] Abstract

This article analyzes destabilizing accidents that occurred in power grids during 1982-1984 in terms of the "Guidelines for Electrical Power System Safety and Stability" issued by the Ministry of Water Resources and Electric Power in 1981.

This analysis will serve as a reference for future grid design and operation and it summarizes some related technical experiences.

1. Outline

Destabilizing accidents in power grids occurred frequently from 1970 to 1980, causing power outages over large areas and very substantial losses. In 1980, the National Power Industry Safety and Production Conference called for making prevention of destabilizing accidents in power grids the focus of the fight for accident prevention. The National Power Grid Stability Conference held in 1981 summarized experiences in work related to power grid safety and stability. It analyzed grid accidents since 1970, held discussions and revised the "Guidelines for Electrical Power System Safety and Stability" (abbreviated below as the "Stability Guidelines"). The conference studied certain programs related to improvement of power grid management levels and it called for a substantial decrease in destabilizing accidents in power grids.

Following the National Power Grid Stability Conference, the attention paid to grid management by leaders at all levels and the analysis of stability in existing and future power grids according to the "Stability Guidelines" led to gradual improvements in grid structures and strengthened management of grid operations. This was especillay true of work on stability measures like rapid protection, reclose, oscillation removal, automatic generator cutoff, cutoff load and others. This improved safety and stabilty levels. The result was a 56 percent decrease in the annual number of national power grid destabilizing accidents from 1982-1984 as compared with 1970-1980.

Most grids met the National Power Grid Stability Conference's call for a substantial reduction in power grid destabilizing accidents.

II. Experiences

There were two main reasons for the substantial decresase in power grid destabilizing accidents. The first was that all levels of leadership clearly understood the idea that "power management first of all is grid management" and gave conscientious attention to grid work after the National Power Grid Stability Conference. The second reason was that the "Stability Guidelines" provided the necessary instructions for power grid construction and for safety and stability.

The efforts of leaders at all levels and power grid work personnel have led to real effectiveness in two areas, and they have become the primary experiences for improving power grid safety and stability levels:

1. A rational strengthening of power grid structures is the material foundation for improvingment of safety and stability levels in power grids.

Most destabilizing accidents occurred in fully integrated grids in the past. Voltage increases and transformation in the primary parts have led to an immediate change in the past situation of frequent destabilizing accidents. This is a typical example.

The East China Grid strengthened the Shanghai-Hangzhou-Changzhou triangular simple ring grid and changed it to a dual-circuit ring grid and provided voltage assistance from the main power plants. It was tested by two failures in the 220 KV bus at the Wangting and Jianbi power plants and did not cause any distabilizing accidents in the grid. The North China Grid used 10 groups of dual circuits to link up the Beijing-Tianjin-Tangshan concentrated load region. Although destabilizing accidents have occurred in recent years, they have not affected the entire Beijing-Tianjin-Tangshan primary grid. Another example is the Shenyang-Fushun-Benxi-Anshan region in the Northeast Grid. Like the East China and North China Grids, it has been built up over many years and gradually formed a receving-end system with relatively concentrated loads and power sources linked into a rather strong network. This has formed a grid nucleus and has played a decisive role in improving safety and stability levels in all of the grids, especially in the area of preventng whole-grid power outages over large areas. This is an important successful experience in construction of grid structures.

Through surveys of each grid and the efforts of grid work groups in recent years and based on more than a decade of developmental trends in the electric power system and problems of current development, the Ministry published the "Electric Power System Technical Guidelines (Trial)" in order to adapt to rapid development of the electrical power system, to the one-grade voltage increase in large grids, generators and regional networks and to the gradual appearance of a new situation in high-voltage DC power transmission and other areas. It also summarizes experiences in grid construction and operation.

2. The results of strengthened management of grid operations are obvious

Strengthened management of grid operations first of all requires comprehensive analysis and research on grids to gain a thorough grasp of the situation, fully understand laws and adopt various feasible measures. To achieve this, most grids have organized small special groups to do a large amount of analysis and calculation in power grids in strict accordance with the "Stability Guidelines" to gain a clear understanding.

Jilin Province formerly had six 220 KV and 66 KV electromagnetic looped networks. Destabilizing accidents and oveloading problems occurred several times in the past. The loop was eliminated entirely after the study and analysis, while operation patterns and relay protection were simplified. Operations have been excellent since.

Analysis of stability and proof in practice have led to the realization in many grids that perfection of rapid protection and the related automatic safety equipment are the key measures for making fundamental changes in unsafe situations in grids. All of these grids have put a large amount of high frequency protection, bus protection and phase current rapid cutoff into operation for this reason. Reclose, oscillation elimination, generator cutoff, load cutoff and other measures have been adopted successfully. Three prevention lines now have been established in accordance with the "Stability Guidelines". The East China Grid, for example, put 32 high frequency protectors and 15 bus protecors into operation between 1981 and 1983. By 1984, 186 high frequency protectors has been put into operation on 123 different 220 KV lines. Nearly every line has rapid protection. At the same time, they also improved reclose and high frequency breech distance protection. Areas requiring grid stability achieved 0.1 second cut-out of alternating malfunctions in nearby areas. This has caused many dangerous parts of grids to have achieved a level of sustained stability during three-phase short-circuits.

Stability problems idled the Gezhouba power station during a major period of hydroelectric power generation at the end of 1983. The Central China Grid earnestly implemented the "Stability Guidelines" in 1984 and, with assistance from the Academy of Electrical Sciences, undertook extensive analyses and calculations concerning stability. Through the efforts of comrades in the Central China Grid, they achieved measures for faster malfunction cut-out times, generator cut-out times and so on. This made it possible for the Gezhouba power station to generate electricity in excess of specifications, with output reaching 1,000 MW. Not only were there no stability restrictions, but in many situations they also were raised to the level of sustained stability during three-phase short-circuits. This was especially true in an accident in a certain thermal power plant in October 1984, when two 300 MW generators were forced to shut down. the Gezhouba power station played a major role in guaranteeing safe and stable operation throughout the grid.

III. Analysis

Several destabilizing accidents still occurred in power grids from 1982 to 1984, which indicates that many problems remain in grid work. An analysis follows.

1. Prominent accidents in certian grids

Continued operation of a 220 KV and 110 KV electromagnetic looped network by a structurally-weak independent grid caused accidental breakages of a 220 KV line. This often destroyed stability in the grid and occurred many times between 1982 and 1984.

Although only one instance of a destabilization accident occurred in an independent grid in a certain province over several years, frequent high loads on the connecting lines caused several instances of tripping and loss of magnetism in one of the grid's 200 MW generators after linking up with a large grid through a long-range single loop network. Each time there were destabilizing accidents in both of the grids. Three-phase short-circuits occurred on the province's provincial CPC Committee 66 KV line. The cut-out was extended because of the lack of bus protection and also caused destabilizing accidentss in the grid.

Destabilizing accidents in these two provinces have accounted for nearly half the total number of accidents. If an independent grid fails to absorb the experiences and lessons of other grids during the developmental process or when interconnceting with large grids, it will be impossible to examine and adopt the corresponding measures in the "Stability Guidelines." This would make avoidance of frequent similar accidents impossible.

2. Analysis of malfunctions.

Destabilizing accidents resulting from extended cut-out during three-phase short-circuits accounted for 28 percent. They occurred in greater numbers on 110 KV (and 66KV) lines than on 220 KV lines. They were more common on the lines than on buses. It is obvious that three-phase short-circuits cannot be ignored. Moreover, large three-phase short-circuit accidents have not created destabilization. A great deal of anlaysis and calculation in each of the systems shows that grid structures must be able to meet the basic needs of guaranteed stability during permanent single-phase malfunctions. This depends primiarly on faster malfunction cut-out times and requires the adoption of supplementary measures. It will be possible in such cases to meet the requirements for stability maintenance during three-phase short-circuits as proposed in the "Stability Guidelines."

Destabilizing accidents caused by tripping or loss of magnetism in large generators accounted for 24 percent. The effects on stability of a loss of magnetism in large generators were more serious than the effects of tripping. The "Stability Guidelines" clearly stipulate that this type of malfunction must be considered and that preventive measures should be adopted.

Single-phase grounding accounted for 40 percent of destabilizing accidents, while two-phase grounding accounted for 8 percent. This shows that the No 1 protection line in these grids is not strong. The reasons include weak grid structures, inadequate rapid protection, aborted reclose and other factors.

3. Analysis of grid structures and operation patterns

Most destabilizing accidents from 1982 to 1984 continued to occur in weakly-intergrated grid structures. Some 32 percent of them occurred in electromagnetic looped networks and long-range single loop connecting lines. Very large weakly-integrated grids and grids with excessively weak receiving end systems accounted for 4 percent, for a total of 72 percent.

The question that deserves special mention is the one of electromagnetic looped networks. Many comrades feel from practice that looped networks are unsafe, and many areas have eliminated looped operations. Some, however, still feel that maintenance of looped networks is a safe form of electricity supply. Not only have they failed to analyze safety and stability in existing electromagnetic looped networks, but they have also not installed automatic cut-out measures as a necessary condition for electromagnetic looped network operation. What have the results been? A grid in one province, for example, has 220 KV and 110 KV lines interconnecting it with a large grid. they felt that the 110 KV line had a major load at a coal mine, so they maintained electromagnetic looped network operation. The result was another malfunction and break in the 220 KV line and the occurrence of oscillation in the 110 KV connecting lines between the two grids. The center of oscillation was located very near the 110 KV transformer site at the coal mine load. The intensity of the voltage waves seriously endangered the supply of electricty to the coal mine. Luckily, an erroneous tripping of the connecting line distance protection cuased by the oscillation played a major role in cut-out. Otherwise, the outcome would have been unthinkable.

Some 20 percent of the destabilizing accidents between 1982 and 1984 were caused by malfunctions in low-voltage grids. In order to guarantee that malfunctions in low-voltage grids do no affect the stabilty of high-voltage grids, an important measure to adopt in the area of network structure and operation when a region or city is building a one-grade higher voltage grid for electricity supply is that all low-voltage grids should be simplified and transformed and electricity should be supplied by areas. Examples include the adoption of a loop arrangement for open-loop operation, single loop radiative operation, and operation of dual-loop or mutli-loop operation for electricity supply with split power reception. Relay protection and reclose can be simplified under such conditions, malfunction cut-out time can be speeded up and the reclose success rate can be improved. The use of self-input power sources should be increased in appropriate locations. The result will be greatly improved reliability in regional electricity supply compared with "looped electricity supply."

A certain grid uses a dual loop to supply electricity to an important user. Because the user insists on closed-loop operation, extremely complex protection had to be installed. A malfunction in one loop often causes a full shutdown because of protection or switching rejection. In August of 1984, one of the

loops underwent three-phase short-circuiting because of lightening. The length of the cut-out time caused a destablilizing accident in the grid and also affected the supply of electricity to users. This illustrates the necessity of simplifying network operation.

4. Analysis of relay protection

Of the power grid destabilizing accidents nationwide between 1970 and 1980, 41 percent were related to the imcomplete relay protection, erroneous action or rejection. The substantial decreease in destabilizing accidents between 1982 and 1984 strengthened the important role of rapid protection, but half still were related to the question of relay protection. They can be analyzed as follows:

a) Destabilizing accidents caused by malfunctions under conditions of no bus protection accounted for 16 percent. The inability of bus malfunctions to achieve rapid cut-out seriously endangers grid safety and stability. Some areas have feared that bus protection would not operate properly and have not installed it or put it into operation for a long time. Statistics indicate that there were no erroneous actions in bus protection on lines at 220 KV or above throughout China in 1983. This shows that bus protection is safe and reliable if ground circuits and their layout are correct and if examination is strengthened. For this reason, all buses requiring stability should install and utilize bus protection.

b) Destabilizing accidents caused by a failure to utilize high frequency protection and long malfunction cut-out times accounted for 16 percent. This means that the utilization and operation rates of high-frequency protection plays an important role in guaranteeing grid safety.

c) Problems in distance protection accounted for 12 percent of destabilizing accidents. Some were due to mismatching, a failure to put high frequency protection into operation or a section without distance protection. The result is long malfunction cut-out times. Some were due to inappropriate utilization, where oscillation breech still is used on single power source radiating lines. Breeching of the rapid section during a sustained malfunction lengthened malfunction cutoff times.

d) Single-phase aborted reclose caused 8 percent of destabilizing accidents. All were single-phase transitory accidents. If single-phase reclose is successful, no accident will occur. Some were due to improper layouts (layout of auxiliary current components failed to avoid capacitive line currents). Other were due to large resistance grounding malfunctions or rejection by phase-selection components. The refult every time was three-phase tripping and unsuccessful single-phase reclose.

IV. Conclusions

1. The basic reasons for destabilizing accidents from 1982 to 1984 continued to be weak grid structures, electromagnetic looped network operation (without the corresponding measures), incomplete rapid protection and many instances of three-phase short-circuiting and generator tripping or loss magnetism, and so

on. Stipulations now have been made for most to them in the "Stability Guidelines." With the exception of problems in grid structures, all of them can be reduced or their occurrence can be avoided if we are able to implement the "Stability Guidelines" in a comprehensive manner.

2. Grid construction should be done in a matching fashion. Only then will it be possible to obtain the optmum comprehensive economic results, and a simultaneous turn-around in the unsafe situation of many destabilizing accidents will be possible as well. For this reason, the principles proposed in the "Electric Power System technical Guidelines (Trial)" promulgated by the Ministry of Water Resources and Electrical Power in 1984 creates the conditions for the gradual achievement of matching construction and technical transformation in power grids.

3. There are two key areas to focus on for guaranteeing safe and stable grid operation. One is to focus on analysis through continued intensive analysis of stability in existing grids, in grids under development, in high voltage and low voltage grids, from networks to electricity generating sets and from single malfunctions to repeated malfunctions. The second is to focus on measures through close integration with analysis of results to improve networks and operation patterns. This is especially true in relation to dealing more directly with rapid protection and automatic safety equipment or technical transformation in a planned manner. Concentration on these two keys is essential for achievement of the goal of three-line protection lines as stipulated in the "Stability Guidelines."

Reference

1. "Analysis of the Feasibility of Power Grid Structures," DIANLI JISHU No 7, 1984.

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CSO: 4013/151

POWER NETWORK

BRIEFS

HEILONGJIANG 220KV POWER LINE--The 220-kilovolt power transmission line between Shulan County, Jilin Province, and Harbin City, Heilongjiang, was completed and put into operation on 15 May. The building of the transmission line will contribute greatly to relieving the strained situation with regard to power shortages. [Excerpts] [Harbin Heilongjiang Provincial Service in Mandarin 1000 GMT 15 May 85 SK]

CSO: 4013/158

REFORM OF HYDROPOWER CONSTRUCTION SYSTEM DEBATED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 3, 12 Mar 85 pp 4-6

[Article by Li Zizheng [2621 1311 6927]: "A Brief Discussion on the Macro-Reform of Hydropower Construction System"]

[Text] Currently, the scale of hydropower construction is getting larger and larger, technical equipment and specialized personnel have doubled and redoubled and the construction of hydropower stations has joined the ranks of large industrialized production: plants, specialized division of labor, and strict cooperative relations have been formed within enterprises; external and technical connections have increased and production tends to be socialized. If we continue to use the same organizational structure we used in the past, adopt the form of small production and direct production purely on the basis of experience, we will be unable to meet the needs of developing hydropower construction. How can we meet the requirements of major development in our hydropower undertaking by way of reform? Essentially we have to apply the management principles of modern industry and enterprises to deliberate on transforming the basic system and enterprise organization and structure in the macro realms; for the quality of personnel and material technology, we should correspondingly renew and transform construction contingents and technical equipment; in the process of production, we should apply the objective law of engineering itself and organize production in a way that is more scientific and economically rational. In short, we must reform the present state of engineering bureaus that run "societies." This essay presents some of my personal views from the standpoint of construction in the three following areas.

1. Hydropower construction must link up with economic networks of society

For a long time, hydropower engineering bureaus receive their plans, funds, materials, technical equipment and various directives from the Ministry of Water Resources and Electric Power. The leadership makes policy thousands of miles away and exercises direct micro control on enterprises under it. As a result, cooperation and coordination among enterprises are restricted. The entire construction process cannot give full play to the combined role of the socialist economy among different regions, businesses, enterprises and areas of science, education, and culture. Even in cases in which cooperation would bring mutual benefits, this is difficult to realize because of the restriction of subordinate relations.

However, hydropower is an important component of the energy structure, and for certain power-consuming regions it should be the core of their comprehensive economic planning. The construction of large hydropower stations can alter regional environment and economic outlook. This is closely related to the localities. The resettlement of people in the reservoir area, external transport, power, communications and even the supply of materials, technical equipment and daily necessities of staff and workers and their families cannot be carried out independently of the region and local government. If all these tasks can be incorporated into the socioeconomic program of the region where a project is undertaken, planned and arranged as a whole, construction units can save a great deal of manpower, material and financial resources and it will also make it convenient for the leadership to focus its energy on construction. For example, the Emei Cement Plant, which is capable of producing cement for large dams, lies about 47 kilometers from the Tongjiezi project now under construction. At the suggestion of the Seventh Bureau of the Ministry of Water Resources and Electric Power, the provincial government provides support in raw materials and fuel, and by agreement between the higher authorities of the engineering bureau and the cement plant, the Tongjiezi and Ankang Hydropower Stations jointly finance and supply the cement plant with special equipment to produce cement for the large dams of both projects. As a result, the cement plant has increased its income while the two projects have avoided long-distance transprovincial transportation and saved on storage and shipping costs. This has also laid the foundation for future production of cement for large dams in the southwestern region. Moreover, the southwestern region or Sichuan has an abundance and concentration of hydropower resources as well as a heavy industrial structure. Iron and steel, smelting of nonferrous metals and heavy chemical industry are all energy-consuming industries pending development. If these energy-consuming industries along with those of construction materials, forestry, general equipment manufacturing and the development of communications and transportation of the entire region can be given overall consideration and properly arranged in combination with power supply planning, a huge network of economic development can be formed.

In summary, the above views propose the selective establishment of a regional hydropower development corporation. On the one hand, this corporation (branch corporation) comes under the leadership and supervision of the head corporation (parent corporation), and on the other hand it enters a unified market under the coordination and direction of local economic departments in charge and builds extensive economic union and cooperation with different trades. This corporation should have the comprehensive capability to complete the construction of hydropower stations, that is, the capability to undertake planning, survey and design as well as having development agencies. While it receives central government loans in the form of money paid for shares, it also receives funds collected as shares from the locality, units and power-consuming trades. After the completion of power stations, principal and interest are paid by dividend or compensated by electricity through operation departments. In this way, it can link up with the social and economic networks even when the construction of a hydropower station is first prepared, turning the operation of electricity by sole ownership to that by the society and speeding up the development of hydropower. At the same time, it can open

up new paths in the course of change from an economic form that primarily involves a government controlled and hierarchical structure to one that essentially involves economic networks with the functions of government and enterprises separated.

2. Reform existing engineering bureaus, establish specialized construction bureaus

Existing engineering bureaus are oversized and overstaffed, and they are large and complete. They operate small societies and are highly unsuited to the needs of today's hydropower construction and must be changed. How do we change them? We must be determined to conduct major surgery, streamline administration and turn the huge and comprehensive engineering bureaus into a number of specialized and enterprise-oriented construction bureaus capable of carrying out construction work independently, such as in earth-rock excavation, dam construction, foundation treatment, electromechanical installation, architectural refitting and construction preparation. As for production services and auxiliary production systems, most of them should be oriented toward construction sites and the society by which arrangement can be made for the old, weak, sick and handicapped personnel first streamlined. Centers of vehicle supply, electromechanical equipment supply, material supply and services as well as mechanical repair services may be established. Relations among construction bureaus and among their plants are economic and business in nature, and specialized construction bureaus of the same type may compete with each other in the form of bidding. To the state, a regional development corporation is a legal person contracting construction jobs of entire hydropower stations; its relationship to the bureaus and plants is one of business guidance and separate economic contracts.

At present, all engineering bureaus have a fair amount of fixed assets which are primarily construction machinery and equipment. But the common case is that: the machines are diverse in models and outdated and there is no supply of spare parts. The rate of usability and rate of utilization are both low. Rear maintenance personnel is overstaffed, the turnaround time for repair is long and repair costs exceed the budget, with the result that more of the various machines are idle than operating. In the future, if various specialized construction bureaus and different service centers are established, the specialized bureaus may rent machinery and equipment from the appropriate "centers" according to needs and assume responsibility for their minor repair and maintenance. A service center undertakes major and intermediate repair on equipment according to planning, dispatches repair personnel to station at the construction site by taking into account conditions of the project and returns it to the base for repair if necessary, which will increase the rate of usability and rate of utilization of various machinery. In order to further streamline the personnel of a specialized bureau, a service center may also provide machinery and operators at the same time with wages and bonuses paid by the specialized construction bureau.

Once the reform is carried out, a coordinating body will be needed at the construction site to take general charge of contracting units and supervise

the progress and quality of the project and the use of funds. This body may be called "project headquarters" or by other names. Its staff is appointed by the development company, and personnel from the various specialized bureaus are invited to join. For large hydropower stations, a construction committee or leadership group needs to be formed above the project headquarters from representatives appointed by leaders at the higher level, the local government, power administrative bureau, major shareholders and the development corporation, representing the state to supervise the execution of the construction plan of the power station. In addition, specialists may be hired and if necessary, foreign specialists may be hired to form a small and authoritative consultative body to offer decisional opinions on major problems of the projects. Upon examination and acceptance of the project, all three bodies will be dissolved.

3. Stress preconstruction preparation, ensure normal sequence of production

In the early phase of construction, it usually takes 20 to 30 percent of the total construction time to set up all the production services and auxiliary production systems which represent more than 10 percent of the total construction cost. The one lesson learned from many projects has been: inadequate preparation, rushing to make a start or starting anyway when the conditions are inadequate, which frequently cause suspension, waste, delay, and poor quality of the project. Therefore, it is imperative to be well prepared at the early phase of construction.

The main task of preconstruction preparation is to bring the entire project under scientific management before construction of the project begins and lay the foundation for the gradual realization of modern management in the future. The major measures are: (1) standardize and regularize the processes and methods of the operations of major construction items on the basis of summing up experiences in the construction of power stations at home and abroad by drawing up "design for construction technology, organization and measures" of the project; (2) work out standard serialized designs from auxiliary production systems according to different production scales (quantity levels), requiring the structure to be assembled and forming specialized and combined equipment which can be used and reused; (3) based on the design information mentioned above, organize subordinate plants or cooperate with enterprises of the society, sell as commodities or lease to various construction sites the equipment needed for processing and construction and whole sets of auxiliary production facilities.

In doing so, the "design for construction technology, organization and measures" has to carry the authority of a directive. Contract units must act in accordance with approved documents and cannot revise and simplify them freely or formulate another set. For example, the "two blends" and "three forms" are meant to be prescriptive and popularized with no modifications, not to be changed to accommodate different situations. At present, of the vast auxiliary production systems for hydropower construction, only one item, the mixer plant, can be provided by the ministry as a set. Its specifications are incomplete, which therefore cannot be serialized. For the majority of other items, construction units would have to search all over

the country to order them and to have them customized. The amount of processing of non-standardized specifications is large, which wastes money and time and with no guarantee of results. If standard serialized designs are available for different quantity levels of auxiliary production systems and if complementary parts of these specialized equipment can be supplied by service centers under the ministry, and moreover, if auxiliary machinery and complementary parts of main machinery can be designed into lighter assembly components, the amount of temporary on-site work will be significantly reduced. In this way, construction units contracting the project would be able to complete project preparation quickly and satisfactorily. At first sight, the cost of this one-time investment of such facilities appears to be very high, but since they can be used and reused, the cost shared by individual projects is actually very low. Moreover, following the overall improvement of the level of construction management, balanced and rational production will bring down the relatively high coefficient of reserve facilities used in the past, and a great deal of funds will be saved when final project costs are calculated. Currently, the most urgent needs are: to establish development agencies, collect information, obtain data, organize S&T interexchange and production cooperation, and finally, provide hydropower construction sites with quality products. In short, the current state of engineering bureaus which run "societies" must be reformed. By doing a good and solid job in preconstruction work, construction will proceed faster, cost will be correspondingly lowered and the quality of construction work will be better assured.

9586
CSO: 4013/123

HYDROPOWER

EXPERTS SEE HYDROPOWER AS KEY TO DEVELOPING WEST

OW160744 Beijing XINHUA in English 0722 GMT 16 Aug 85

[Text] Lanzhou, 16 Aug (XINHUA)--Western China should take advantage of its abundant natural resources for economic growth, a group of scientists and economists said today.

They are now attending a symposium here on development of the area which comprises Shaanxi, Gansu, Qinghai, Sichuan, Yunnan, Guizhou, Ningxia, Xinjiang, Inner Mongolia, Tibet and Guangxi. This is two-thirds of China's total area.

Water power resources in western China account for 80 percent of the country's total; coal, 60 percent; and petroleum and natural gas, 40 percent according to energy experts. It also has abundant solar and wind energy.

The problem is that economically underdeveloped western China has rich energy resources, but the economically developed east lacks them.

Having good use of the west's energy resources can both help solve the energy shortage in the east and promote economic growth in the area.

They recommend priority to developing power, hydropower in particular, in the area.

They suggest a series of 15 hydropower stations to be built in [cascade arrangement] to take advantage of the total drop of 1,465 meters from Longyangxia in Qinghai to Qingtongxia in Ningxia on a 900-km section of the Yellow River. With a combined generating capacity of 13 million kilowatts, such a group could generate 50 billion kWh of electricity a year.

Another suggestion is that six big thermal power plants should be built at coal mines in Inner Mongolia, Shaanxi, Ningxia and southwest China.

Energy-oriented economic bases should be built in the following provinces and autonomous regions, they say:

Shaanxi: coal and machine building,

Gansu: metallurgy, oil refining and machine building,

Ningxia: coal and chemicals,

Qinghai: hydropower, aluminum smelting and chemicals,

Xinjiang: petroleum and metallurgy,

Inner Mongolia: coal, metallurgy and chemicals,

Sichuan: metallurgy, chemicals and machine building,

Guizhou: aluminum smelting and chemicals,

Yunnan: hydropower, metallurgy and chemicals and

Guangxi: hydropower and aluminum smelting.

The scientists and economists said preferential measures like reduced taxation, low-interest and interest-free loans and investment in compensation trade should be applied to western China.

A high wage system should be adopted, they added, saying that a price system suitable to develop energy should be worked out.

CSO: 4010/166

HYDROPOWER

SANXIA: THE FOCUS OF WORLD ATTENTION

Beijing DILI ZHISHI [GEOGRAPHICAL KNOWLEDGE] in Chinese No 4, 7 Apr 85 pp 5-6

[Article by Gao Xia [7559 0204]]

[Text] I boarded the river steamer from Chongqing to Wuhan and sailed downstream with the current. When one enters Xiling Gorge as the boat passes between Xiangxi and Huanglingmiao, the only things visible are the mountain walls along either bank. The gorge has been filled in and levelled and a harbor with all kinds of mechanical equipment has been built. The engines roar and the view is one of intense activity. Work in preparation for construction of the world-famous Sanxia [Three Gorges] Hydropower station project is now underway.

I. A Long-Cherished Wish of the Chinese People

Construction of the Sanxia Hydropower Station has been a long-cherished wish of Chinese people for nearly half a century.

Sun Yat-sen, a pioneer of the Chinese democratic revolution, pointed at the beginning of this century in his "Outline for National Construction" that "Above Yichang, the Chang Jiang is contained by the rock along each bank, making it narrow and deep. The flow is fierce and there are shoals and rocks. Everything must follow the current. Improvement of the section above here and damming its waters with a lock can open it to navigation and also make use of its hydropower." During the winter of 1932, the Guomindang government sent a group of five people including Yun Zhen [1926 7201] to survey and explore the Sanxia section of the river. They selected Huanglingmiao and Gezhouba as sites for two dams. During the 1940's, the Guomindang government cooperated with the U.S. Department of the Interior's Bureau of Reclamation, and under the leadership of the famous American engineer (Sanfanqi), Chinese and American engineering and technical personnel were organized to carry out research and develop planning work concerning the Sanxia project. Later, however, the Guomindang government was busy dealing with the civil war and basically had no interest in taking part in the construction. Work to develop Sanxia finally came to nothing.

After the nation was founded, the party and people's government paid strong attention to development of the hydropower of Sanxia. In February 1958, Premier Zhou Enlai convened a conference on "Actively Preparing for Construction of the Sanxia Key Water Conservancy Project." Thereafter, he lead comrades from

related ministries and committees and responsible comrades and specialists from the related provinces and cities to make a personal inspection of the Sanxia dam site. The CPC Central Committee also convened a meeting during the same year for special discussions on development plans for the Sanxia project and control of the Chang Jiang basin. In August 1958, Preimer Zhou also headed the Chang Jiang Sanxia Conference and pointed out the valuable hypothesis that real forces in the Sanxia project could be placed at Sandouping at that time for growth in the Sandouping region.

In accordance with the spirit of the articles passed by the CPC Central Committee, joint preparations for construction were made by the Ministry of Water Resources and Electric Power, the Chinese Academy of Sciences, the First Ministry of Light Industry and the Chang Jiang Basin Planning Office from 5 to 16 June 1958 and the "Scientific and Technical Research Conference on the Sanxia Key Water Conservancy Project" was convened in Wuhan. After the meeting, scientific research concerning Sanxia was coordinated on a national scale. More than 200 units and more than 10,000 scientific and technical personnel were organized for attacks on key technical problems. By 1960, the number of units participating in key scientific research projects related to Sanxia had reached 360. They issued a total of 1,376 research reports and solved 14 major problems to different degrees. At the same time, the Chang Jiang Basin Planning Office [referred to hereafter as the Chang Jiang Office] completed its "Report on the Key Points of Preliminary Design of the Sanxia Key Water Conservancy Project" in 1958. The Chang Jiang Office also issued a "Construction Program and Preparation Plan for the Sanxia Key Water Conservancy Project" in 1960. The difficulties faced by the national economy after 1960, however, as well as the chaotic decade of the "Cultural Revolution" that followed in combination with other reasons caused construction of the Sanxia project to be postponed.

After the 3d Plenum of the 11th CPC Central Committee, China undertook construction of the Four Modernizations, which dramatically increased demand for electrical power in all sectors and activities. The Sanxia project became the order to the day. On the basis of long-term work, the Chang Jiang Office issued its "Report on the Supplementary Design Stage for Selection of Dam Sites for the Chang Jiang Key Water Conservancy Project." The State Council entrusted the [former] Ministry of Water Conservancy to organize an on-site conference in 1979, which recommended a program for the Sandouping dam site. The CPC Central Committee has given special attention to construction of the Sanxia project since the 12th CPC Central Committee and has speeded up exploration, design, and scientific research work. By 1982, 854 bore holes with a total depth of 65,209 meters had been drilled at the Sandouping dam site alone. Six tunnels totalling 503 meters in length were dug and 11 large-diameter bore holes were dug. These provided reliable primary geological information for construction of the large Sanxia dam.

In March 1983, the Chang Jiang Office issued its Feasibility Study Report on the Chang Jiang Sanxia Key Water Conservancy Project." In the same year, Yao Yilin [1202 0181 2651], vice premier of the State Council was in charge of convening the "Examination Conference for the Research Report on the Feasibility of the Sanxia Key Water Conservancy Project." Through serious and earnest examination, the conference made an evaluation of the Chang Jian Office's

"Feasibility Research Report" that determined truth based on fact and proposed that the State Council approve this report in principle. The State Council approved the "Sanxia Project Feasibility Research Report" that determined truth based on fact and proposed that the State Council approve this report in principles. The State Council approved the "Sanxia Project Feasibility Research Report" in April 1984 and decided to make good pre-construction preparations for the main body of the project during 1984 and 1985. They are striving to begin formal construction in 1986. After more than half a century and more than 30 years of exploration and design since Liberation, the Sanxia project, which has been a long-cherished desire of countless people for economic development in China and the sweat and blood of specialist and scholars, will become a reality during this century.

II. A Magnificent Project

The Sanxia hydropower project is located in the municipality of Yichang Hubei Province, 40 kilometers upstream from the Gezhouba hydropower station that now is under construction.

The Chang Jiang Sanxia [Three Gorges] start in Sichuan Province's Fengjie County and extend over a total length of about 200 kilometers to Nanjinguan in Hubei's Yichang to the east. They are composed of three gorge sections moving from west to east: Qutang Gorge, Wu Gorge and Xiling Gorge. The river gorges are very deep and the mountain peaks along either bank are extremely beautiful. The area has become world famous for its beautiful scenery. An examination of the area's geological history shows that during the Cretaceous Era, which ran from 67 to 137 million years ago, the water systems in the Sichuan Basin and in the lower reaches of the Chang Jiang were cut off from each other. Orogeny during the later part of the Cretaceous uplifted the Sichuan Basin and denudation developed intensely toward the source of the Chang Jiang. The intersecting mountain ridges captured the river basins of the Sichuan Basin and became increasingly deeper, forming the world-famous large gorge area at Sanxia. The walls on either side are 400 to 500 meters above the river surface and restrict the river surface, generally to a width of 250 to 350 meters. The narrowest section is 140 meters wide, and the maximum depth is 110 meters, which is below sea level. The maximum flow is 7 meters/second. There is an enormous 220-meter drop in the section of the river between Yibin and Yichang. In combination with the long-term average annual flow rate of 14,300 cubic meters/second, the volume of water in the river averages 453 billion cubic meters/year. This means that there are enormous latent hydropower resources in this section of the river, with total reserves of 30 billion kW.

The dam site selected for the Sanxia hydropwer project is at Sandouping in Hubei's Zigui County. The geological conditions here are superior. The bedrock is very hard igneous rock. The pressure-resistant strength of the rock is more than 1,000 kg/cm2, and the permeability of the bedrock is very low. It is suited to the construction of a high concrete dam. The river is a bit wider here, which can facilitate the deployment of the construction materials and construction of the entire hydropower project. There is a small island known at Zhongbao Island on the right side of the river gorge at the Sandouping dam site. The island is about 1,000 meters long and 200 meters wide. The left side of Zhongbao Island is the main river gorge, while the right side is a

tributary channel. The Sanxia project design calls for construction of a large concrete dam with a total length of about 2,000 meters that extends over Zhongbao Island. The elevation of the top of the dam will be 175 meters, with a maximum dam height of 165 meters. It includes sluice facilities capable of supplying 110,000 cubic meters/second, an electric power plant and a boat lock.

There will be 26 50,000 kW single unit generators installed in the Sanxia power station for a total installed capacity of 13,000 MW. Annual electricity output will be 65 billion kWh. This is equivalent to 4.8 times the capacity of the Gezhouba hydropower station, the largest in China at the present time. The total installed generator capacity will exceed that of the joint Brazilian-Paraguayan Itaipu hydropower station by more than 40,000 kilowatts, making it the largest hydropower station in the world.

The huge Sanxia dam will be much higher than the current large Gezhouba dam. When navigating upstream at the dam, vessels will rise by 107 meters, while the rise at Gezhouba is only 27 meters. At the same time, it will open the Chang Jiang, this important economic lifeline, to year-round unobstructed navigation. Moreover, dual-direction multilevel boat locks will be built, each of the locks being 280 meters long and 34 meters wide.

The scale of construction of the Sanxia project is enormous. It not only will take first place in China, but also will become one of the largest hydropower construction projects in the world. It will require excavation of more than 100 million cubic meters of earth, the pouring of more than 20 million cubic meters of concrete and the installation of more than 170,000 tons of metallic structures. It will require more than 300,000 tons of steel, more than 400,000 tons of lumber, more than 4.7 million tons of cement and has a planned total investment of 20 billion yuan.

III. Enormous Economic Benefits

The Sanxia hydropower project is being built on China's largest river, the trunk of the Chang Jiang, and is located in the center of China's economically developed region. It is a project that will provide many benefits, including power generation, flood prevention, shipping etc.

It has the enormous capacity of generating 65 billion kWh per year. This can increase the total value of industrial and agricultural output nationwide by 200 billion yuan per year, and each person in China would gain nearly 200 yuan in value of output per year. This electricity could conserve 40 million tons of coal each year, and it is inexhaustible. The electric power generated by the Sanxia hydropower station can be supplied to Chongquing in the west, to Shanghai in the east, to Henan and Hebei in the north, and to Hunan and Guangdong in the south. This could make Sanxia the center of a large power grid that links up eastern, central, southern, southwestern, and even northern China. This would provide low-cost electrical energy for areas with coal resource shortages like Hubei, Hunan, Sichuan, Jiangsu, Zhejiang, Shanghai, and Jiangxi. This would promote further economic development of the national economy over a vast area and also reduce the pressures on railway transport for shipments of coal from the north to the south and the east.

The Sanxia project will control an upstream river basin that covers an area of 1 million square kilometers and runoff totalling 453 billion cubic meteres. The reservoir surface area at the normal water storage level in the Sanxia Reservoir will cover more than 570 square kilometers. It will store more than 30 billion cubic meters of water, which will play an important role in flood prevention in the middle and lower reaches of the Chang Jiang. The area covered by the Chang Jiang expands after it passes through Sanxia and the flow becomes more gentle. This is especially true in the Jing Jiang section, which has a winding channel. Silt is deposited on the river bed, causing it to rise continuously to a height greater than that of the farmland on the outer side of the large Jing Jiang dikes. This historically has led to frequent flooding. A fairly major flood occurred on an average of roughly every 10 years over a 100-year period in the middle and lower reaches of the Chang Jiang downstream from Yichang. During this century, the major flood in 1931 flooded more than 50 million mu of farmland in the middle and lower reaches and affected more than 30 million people. More than 140,000 were drowned, and incomplete statistics indicate total property losses of 1.35 billion silver yuan. After Liberation, the 1954 flood inundated more than 47 million mu of farmland and affected more than 18 million persons. More than 30,000 people died. Total property losses in the flooded region were counted in the 10's of billions of yuan. After the Sanxia hydropower project is completed, it will control two-thirds of the floodwater in the section of the Chang Jiang above Hankou. There will be no flood diversion in the Jing Jiang flood diversion area downstream, which can solve problems related to floods of a severity occurring once each century. In order to surpass floodwater conditions in floods of a severity occurring every 100 or even 1,000 years, we can rely on the Sanxia Reservoir to reduce peak flooding, and with the addition of planned flood diversion in the flood diversion region, we can strive to prevent the large Jing Jiang dam from bursting and guarantee the safety of Wuham City. The Chuan Jiang shipping channel between Yibin and Yichang has many shoals and rapid flow. Navigation is difficult and shipping costs are high. After completion of the Sanxia Reservoir, the backwater region of the reservoir can approach Changshou. The rapid current and dangerous shoals between Changshou and Yichang basically will be covered by the backwater and a 400-to-500-meter-long deepwater shipping channel can be formed in the area of the reservoir. Below Yichang, the flow will pass through integrated regulation by the reservoirs at Sanxia and Gezhouba. Flow can be increased during the dry season to improve winter and spring navigational conditions in the middle and lower reaches.

Fish-raising activities also can be developed on the 2 million mu of surface area in the reservoir.

After the Sanxia project is completed, the beautiful scene of a lake in the high gorges and especially the unrivalled Sanxia hydropower station project will attract more tourists from China and abroad and can promote the development of tourism in China.

In summary, the magnificent Sanxia project will be completed at the end of this century. It will play an important role in invigorating the socialists economy and for achieveing a quadrupling of the total value of industrial and agricultural output [by the end of this century].

12539
CSO: 4013/144

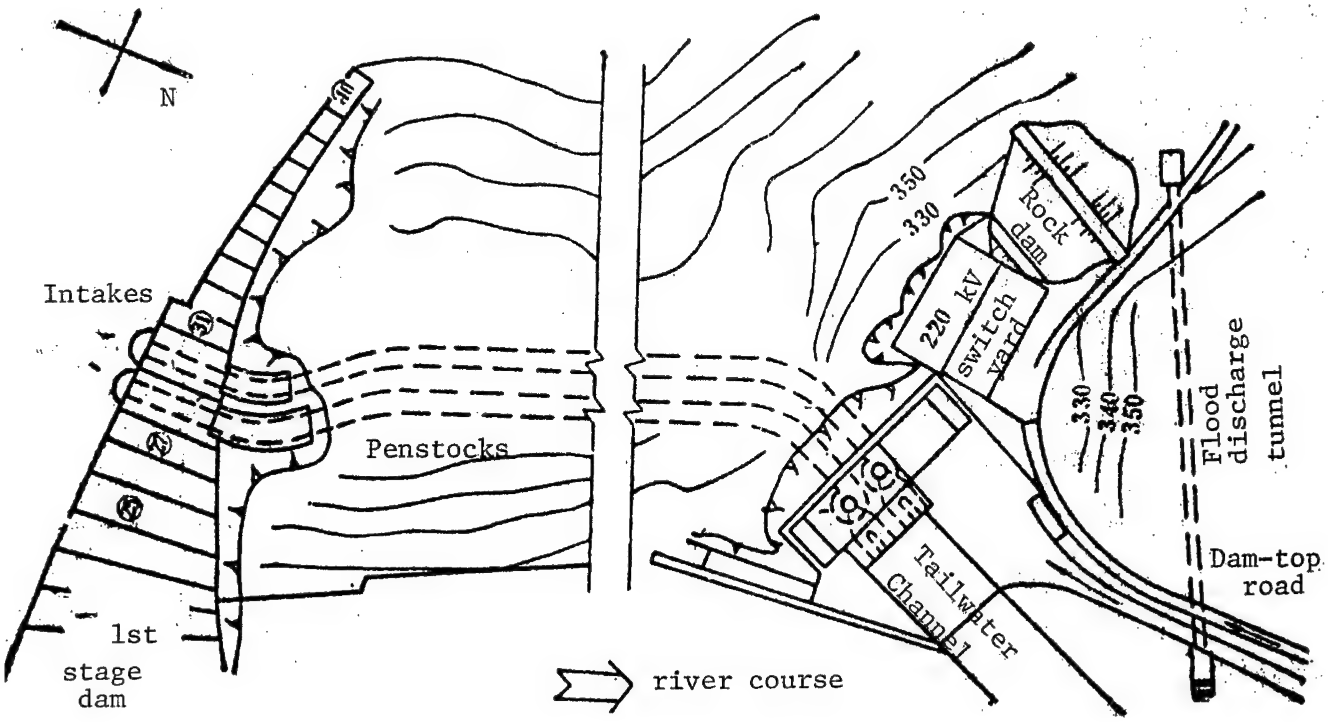
HYDROPOWER

SECOND-STAGE PROJECT OF BAISHAN DETAILED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 7, 12 Jul 85 p 47

[Text] The Baishan hydroelectric power station is located on the Di'er Songhua Jiang in Huadian County, Jilin Province. The first-stage project of this hydropower station is nearing completion and three hydraulic turbine generators rated at 300,000 kilowatts [installed capacity] each became operational in December 1983, and in June and December 1984 respectively, playing an important role in easing the chronic power shortage in the northeast power grid. But because the power shortage in the northeast is so severe and since the proportion of hydropower in the system is dropping (it occupies less than 20 percent), the problem of regulation and frequency modulation in the system remains acute. This frequently forces the use of thermal power to handle regulation and frequency modulation resulting in poor economic benefits and operating reliability. Because of this, the Northeast Survey and Design Institute of the Ministry of Water Resources and Electric Power, after thoroughly considering the economics of the system's operation, submitted a "preparatory report on the second-stage expansion of the Baishan Hydroelectric Power Station" in 1978. In 1982 they completed the initial design for this second-stage project. The principal aim of the second-stage is to increase the system's regulatory capacity and the quality of the electricity supplied without having to acquire additional power capacity.

The Baishan Hydroelectric Power Station second-stage plans call for the installation of two generators with a total installed capacity of 600,000 kW (2 X 300,000 kW). After the units have become operational the reservoir level will be 413 meters and the dead-water level will increase from 372 meters to 380 meters; guaranteed output will drop from 1.67 million kilowatts to 1.63 million kilowatts and the yearly output will increase from 2.003 billion kilowatt-hours to 2.037 billion kilowatt-hours. Total investment in the project will be 190 million yuan (not counting some 10 million yuan for external capital construction costs), for a per unit kilowatt investment of 314 yuan. The Baishan hydropower station is close to the power grid load center, and the reservoir has a good regulatory capability, the per unit kilowatt investment for the expansion project is low and the economic return will be outstanding.



Schematic drawing of the second-stage project of the Baishan hydropower station.

The main portions of the second-stage project for Baishan include two intakes on the left bank section of the existing dam (dam sections 28 and 29), power tunnels [penstocks], a power house on the downstream side of the left bank of the main dam, and an flood discharge tunnel. The bottoms of the intakes are at the 365-meter level and the diameter of the power tunnels is 8 meters; their average length is approximately 465 meters. The power house, measuring 101 meters in length, 26 meters in width, and 51.4 meters in height, is situated approximately 400 meters downstream from the dam on the left bank; the switching yard is located on the left side of the power house and has two outgoing 220 kV power lines. In order to avoid flooding of the power house during the ice thaw-flood season, a rock-fill dam and a flood discharge tunnel is provided to channel the water downstream. The crest of the rock-fill dam is at the 335-meter point and the maximum dam height is 21 meters; the dam is 94.5 meters long at the crest and 6 meters wide at the crest. The base is approximately 114 meters wide and the flood discharge tunnel is located to the left of the rock-fill dam and has a 3.8 x 4.5-meter cross-section; it is approximately 235 meters long.

The Baishan second-stage project involves the excavation of 550,000 cubic meters of earth and rock, 240,000 cubic meters of steel reinforced concrete, 12,048 tons of steel materials, 3,432 tons of reinforcing

rods, and 36,400 square meters of backfill grouting. The project is being built by the First Hydropower Bureau. Preparations for construction were begun in 1984 and work got under way on the main portion of the project in the second half of 1985. Plans call for the generators to go on stream at the end of 1987 and October of 1988.

CSO: 4013/165

HYDROPOWER

LONGTAN FEASIBILITY STUDY SUBMITTED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 6, 12 Jun 85 pp 46

[Article by Zhang Lanyu [1728 5695 6735] of the Ministry of Water Resources and Electric Power: "The Feasibility Study Report on the Longtan Hydropower Station Has Been Examined"]

[Text] The Longtan hydropower station is located in the upper reaches of the Hongshui He. It is a backbone project in development of the Hongshui He river basin. The project will have a high dam, large reservoir and enormous storage capacity. Its role in regulation and compensation and its economic benefits are extremely obvious. Installed generator capacity will be 5,000 MW at the normal water storage level of 400 m. Guaranteed output will be 1,740 MW and annual power output will be 18.7 billion kWh. Moreover, it can increase the guaranteed output of downstream stepped power stations by 830 MW and their annual power output by 3.3 billion kWh. After completion, the reservoir can improve navigation on 250 km of the trunk of the river in the area of the reservoir. Downstream drainage during dry periods will be 3 times greater than under natural conditions, which will create the conditions for navigation to the sea in the Guizhou and Guangxi regions. It also can improve flood prevention standards downstream and in the Zhu Jiang [Pearl River] delta.

According to comments made by leading comrades in the State Planning Commission, the Ministry of Water resources and Electric Power convened a meeting to examine the "Feasibilty Study Report on the Longtan Hydropower Station" in Beijing from 15 to 22 May 1985. It was felt at the meeting that geological questions at the Longtan hydropower station basically have been clarified and that technical and economic consideration have been demonstrated. It basically meets the intensive requirements of this stage. The meeting agreed in priciple with the feasibility study report prepared by the Central-South Survey and Design Academy of the Ministry of Water Resources and Electric Power and proposed that the state include the Longtan hydropower station in the Seventh Five-Year Plan and that it be constructed as soon as possible.

12539
CSO: 4013/149

HYDROPOWER

THE SHUIKOU HYDROPOWER STATION DETAILED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 6, 12 Jun 85 p 46

[Article by He Genshou [0149 2704 1108] of the Water Conservancy and Hydroelectric Power Construction Corporation]

[Text] The Shuikou hydropower station is located on the trunk of the Min Jiangin Minqing Country, Fujian Province. It lies 94 km downstream from Nanping City, and is 14 km upsteam from the Minqing County seat and 84 km upstream from Fuzhou City. It will become the largest hydropower station in the East China region after it is completed.

The river basin controlled by the Shuikou hydropower station dam site covers an area of more than 52,400 km^2, equal to 86 percent of the area of the entire Min Jiang river basin. There is ample rainfall in the river basin, with long-term average precipitation of 1,758 mm per year. Long-term average flow at the dam site is 1,728 m^3/second.

Annual runoff is 54.5 billion m^3. The greatest measured flow is 30,200 m^3/sec, while the minimum flow is 196 m^3/sec. At the average water level, the river bed is about 380 meters in width at the dam site and both bands have fairly gentle slopes. The bedrock in the area of the dam site is Yanshan period biotite granite. The lithology is hard and integral. Average moist pressure resistance is generally above 1,000 kg/cm^2. The capping strata in the river bed are generally 3 to 11 meters thick and the deep trough has a maximum width of 29 meters. The area around the reservoir region is composed of magmatic rock, clastic rock and other material. There are no low, short divide crests and cols, nor are there any problems with permanent permeability. Moreover, there are no major losses of stability of the reservoir shore.

The Shuikou hydropower station is focused on power generation in combination with additional benefits from shipping. Reservoir capacity at the normal water storage level of 65 m is 2.34 billion m^3. When the water level reaches 70.8 m during periods of peak flooding, total reservoir capacity is 2.97 billion m^3. At the dead water level of 55m, reservoir capacity is 1.50 billion m^3. The effective reservoir capacity is 840 million m^3. The design head for the power station is 45.3 m and total installed generator capacity is 1,400 MW. Guaranteed output is 260 MW and long-term average

annual power output will be 4.95 billion kWh. The power generation benefits of this power station will be equivalent to a 1,000 MW thermal power plant combined with a large coal mine having an annual output of 2.5 million tons of raw coal. The station will practice compensated regulation in combination with the Xin'an Jiang, Fuchun Jiang and other hydropower stations in Zhejiang Province. This will make full use of the long-term regulatory role of the Anjiang reservoir and can increase guaranteed output in the system by more than 50 MW. The East China Power Grid relies mainly on thermal power and has insufficient peak regulation capacity. The Shuikou hydropower station can bear loads of about 1,000 MW, which can permit full use of the economic benefits from integrated operation of hydroelectric and thermal power stations. The total budget approved for the Shuikou hydropower station is 1.818 billion yuan (this figure is calculated from all internal investments and does not include expenditure for the permanent line change on the Waiyang-Fuzhou railroad and the electrical transmission and transformer project), including 1.408 billion yuan in project investments. The costs of compensation for reservoir inundation will be 410 million yuan. Unit investments are 1,299 yuan per kW and 0.37 yuan per kWh. Reservoir flooding was checked in 1982 at 31,394 mu and 57.715 people will be moved out of the area. About 70 km of the Waiyang-Fuzhou railway will be rebuilt.

The Shuikou hydropower station will be composed of a concrete gravity dam, a plant building, dam passage structures and spillways. The plant building will be on the left bank and ship passage structures will be on the right bank. The spillways will be installed in the river bed. The top of the river dam has an elevation of 74 m. The maximum dam height is 100 m and the total length of the dam is 794 m. There are four spillways that are located in the middle of the river bed near the plant building. The elevation of the weir is 45 meters and the holes are 16 meters across. The flow through a single hole during period of maximum flooding is 290 m^3/sec. A bucket will be used for baffling. There will be nine middle spillways located to the right side of the surface spillways. The weir elevation is 40 m and the holes are 13 m across and 14.5 m high. The flows through a single during periods of maximum flooding is 260 m^3/sec. Based on the need to build diversion facilities, there will be 6 low diversion holes in the middle hole dam section to facilitate the blocking of the low diversion holes. A nozzle cutoff flow selector will be used for the baffle. The two low sluice holes are located in a section of the dam on the right side of the river bed near the shipping facilities. The holes are 5 m across and 8 m high. The elevation of the bottom of the intake is 25 m. Flow selection will be used for baffling at the outlet. The plant building is located on the left side of the river bed behind the dam and will have seven 200 MV capacity large-scale axial flow turbine generations. A single intake pipe will be used for each generator, meaning that there will be seven 10.5 m inner diameter steel pipes for the water intakes inside the dam. The length from the surface of the dam to the housing intakes is about 80 m. The main plant building will be about 301 m long, 36 m wide and 62.3 m high. Because the downstream water level is rather high, a sealed reinforced concrete integral plant building structure will be adopted. The site of installation is on the bank at the left end of the plant building. There will be six 500 KV primary transformers, three 220 KV primary transformers and four joined complex transformers, all of them to be installed

in the top level of the auxiliary plant building between the plant and dam. A 500 KV power transmission line about 560 km long will be erected to transmit the elecricity to Hangzhou and into the East China Grid. An additional 220 KV power transmission line will be joined with the Fujian Grid. The 500 KV and 220 KV switching stations will be built downstream from the plant building on the mountain slope on the left bank. There will be three-level navigation facilities, each level about 120 m long, 12 m wide and having a 2.5 m draft. They will be able to handle 500-ton freighters and have an annual passage capacity of 3 million tons. Moreover, there is a plan to leave space for log handling equipment.

There are two programs for construction of the diversion, a clear channel diversion and diversion according to different periods. According to the preliminary arrangements for the clear channel diversion program, the construction period up to the time of operation of the first generator will be about 8 years. The total construction period is 10 years. The amount of work required for the main body of the project is excavation of 8.9 million m^3 of earth, refilling with 3.7 million m^3 of earth and 3.22 million m^3 of concrete and reinforced concrete. The construction and communications situation at the power plant is rather good and the Waiyang-Fuzhou railway passes on the left bank of the dam site. There is a highway running from Gutian to Minqing on the righ bank and the Min Jiang is navigable to steamers between Nanping and Fuzhou.

The Shuikou hydropower station was included among state capital construction preparation projects in 1985 and preparation for preliminary construction now is underway.

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CSO: 4013/149

HYDROPOWER

XIZANG'S YAMZHO YUMCO STATION COULD BE FINISHED BY 1990

HK090357 Lhasa Xizang Regional Service in Mandarin 1130 GMT 8 Jun 85

[Excerpts] On the afternoon of 6 June, Duojie Caidan, secretary of the regional CPC committee and chairman of the regional people's government; (Mao Rubai), deputy secretary of the regional CPC committee; and (Wang Guangxi), secretary general of the regional people's government, met in the small conference room of the Regional People's Government Hall to listen to a report by the Yamzho Yumco hydroelectric station work group, headed by (Cui Jun), deputy director of the Hydroelectricity Command of the Chinese People's Armed Police.

The main content of this report was: While building the Yamzho Yumco hydroelectric station, it is necessary to do a good job in planning urban construction in the area, and make it a satellite town of Lhasa, to create conditions for developing tourism. A high degree of mechanization must be applied in construction. Maximum use must be made of local workers and the specialized contingent in Xizang so as to reduce the number of personnel sent into Xizang. A good foundation must be laid for having the station completed and in operation in 1990.

After hearing (Cui Jun's) report, Comrade Duojie Caidan said with satisfaction: These views are very good. He then added three views: 1) The autonomous region will organize a leadership group to grasp the Yamzho Yumco hydroelectricity station project. 2) The region will provide vigorous financial support. Secretary General (Wang Guangxi) will be responsible for the specific work. 3) Roads, power, and water must be supplied and the plant site levelled. The regional government agrees to this.

Duojie Caidan also stressed: Unless the work is started this year, we will be in a passive situation next year. If roads, power, and water are supplied and the site levelled this year, we will have the initiative in work next year.

The four-man Yamzho Yumco hydroelectric station work group of the Hydroelectricity Command of the Chinese People's Armed Police arrived in Lhasa by plane on 23 May.

CSO: 4013/158

HYDROPOWER

NATION'S LARGEST HYDRAULIC TURBINE UNIT COMPLETED

Beijing ZHONGGUO JIXIE BAO in Chinese 12 Apr 85 p 1

/Report by Zhang Changming /1728 2490 2494/ from Deyang, Sichuan Province: "China's Largest (320,000 KW) Hydraulic Turbine Unit Completed"/

/Text/ On 5 April, the Dongfang Electrical Engineering Works in Sichuan Province successfully completed construction of China's largest (320,000 KW) hydraulic turbine for the Qinghai Longyangxia Power Station.

The Dongfang Electric Engineering Works is one of China's key enterprises manufacturing large-scale power generating equipment. Its production of steam turbogenerators makes up close to one-third of the entire national production. To ensure completion in time of the state's key tasks, this plant has further perfected the economic responsibility system throughout.

The plant transmitted production tasks and technical as well as economic norms together with bonus, allowance and other such matters right down to the shops, allowing them to fix their own encouragement and reward methods. Extra commendations and rewards are awarded to shops for completion of key tasks, a method that greatly stimulated work enthusiasm. The output value of the plant during the first quarter exceeded the plan by 26 percent.

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CSO: 4013/131

HYDROPOWER

GEOLOGIC RECONNAISSANCE MANAGEMENT IN HYDROPOWER CONSTRUCTION DISCUSSED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 4, 12 Apr 85 pp 6-10

[Article: "Basic Demands on Geologic Reconnaissance Management for Water Resources and Hydroelectric Power"]

[Text] (Editor's note: Thie important document, originally titled "Basic Demands on Geologic Reconnaissance Management for Water Resources and Hydroelectric Power," was a result of the National Water Resource and Electric Power Reconnaissance Work Conference held in 1984. After discussion at the conference, suggestions were solicited from every corner and extensive revisions were made. Now the document has been formally released by the Water Conservancy Hydroelectric Power Construction Bureau andthe Water Conservancy Hydroelectric Power Design and Planning Institute of the Ministry of Water Resources and Electric Power. It is reprinted in this journal so that all concerned units may study it and put it into effect.)

Geological reconnaissance work is a cornerstone of water resource and hydroelectric power construction, it is an important link in the chain of putting plans into effect and in doing design work. It is intimately connected to lowering construction costs, selecting the most favorable programs, guaranteeing safe movement, etc. The Water Conservancy Hydroelectric Construction Bureau ("the Bureau") has prepared this document, "Basic Demands on Geologic Reconnaissance Management for Water Resources and Hydroelectric Power," in order to strengthen every type of management work of its subordinate geological reconnaissance institutes, to meet the needs of reform and of the development of water resource and hydroelectric power construction, to "write the second chapter," and to open a new frontier for water resource and hydroelectric power geological reconnaissance work.

I. Geological Reconnaissance Work Must Be Run According to Scientific Principles and Along Correct Ideological Lines

Geological reconnaissance work is the difficult work of revealing nature's secrets, studying the laws of geology and calculating the effect of the geological environment on engineering activities. On one hand, it involves investigation and study, obtaining primary source

data reflecting actual conditions, comprehending objective laws, integrating the characteristics of the engineering project with the demands and making precise criticisms and suggestions. On the other hand, the intrinsic characteristics of geological reconnaissance methods must also be considered to avoid arguments which do not correspond to the actual demands but are loaded down with trivial details.

The most important product of geological reconnaissance work is the comprehensive engineering geology report made at every stage of reconnaissance and design. It must comprehensively utilize every method of reconnaissance, fully bring into play the strong points of every specialization and wrap up engineering geology questions through exposition, argument and solution. It calls for full cooperation to provide the very best geological reconnaissance product for water resource and hydroelectric power construction.

The work of geological reconnaissance must necessarily be divided into stages, and the stages of reconnaissance work should be appropriate to the stages of design work. Roughly, they may be divided thus: planning and site selection; feasibility studies, preliminary design; and technical application. Each stage of the reconnaissance work must be completed in accordance with the demands of the mission, with rules and regulations, with "Demands for Degree of Depth and Quality of Engineering Geology Reconnaissance Work at Every Stage of Reconnaissance and Design Work" and with "Quotas for Water Resource and Hydroelectric Power Engineering Geological REconnaissance Controls." While quality control must be maintained, the limits and the depth of the work must not be exceeded.

The work of geological reconnaissance must also proceed according to the steps of reconnaissance work. The outline of the reconnaissance work to be formed must be laid down. Every task must be assigned rationally. Work must go on in good rhythm at the proper administrative level. Every stage of reconnaissance work must proceed along the following lines: contract the mission; prepare the outline of the reconnaissance work; undertake the topographic and geological reconnaissance work; do prospecting; do experiments and positional measurement; analyze the data; prepare the maps and write the engineering geology report.

Every aspect of reconnaissance work relies on the standards for reconnaissance technology. The depth and content of every stage of work must rely on the rules and regulations and on "Demands for Degree of Depth and Quality of Engineering Geology Reconnaissance Work at Every Stage of Reconnaissance and Design Work." At the same time, we must continually strengthen scientific research work, actively and rationally use new geological theory, new technology and new methods. It must be permeated with all specialized disciplines, to strenuously raise high the level of reconnaissance theory and technology.

II. Reform the Reconnaissance Management System; Promote the Development of Productive Forces

The goal of reform is to liberate and develop productive forces. Essentially, in reforming the reconnaissance management system, we must eliminate every type of orrational management ststem, allow individual reconnaissance units to wield their technical and economic powers with some autonomy, speed the progress if technology, raise the quality of the ranks, give full play to the enthusiasm, initiative and creativity of the broad masses of workers and to provide superior reconnaissance data for water resource and hydroelectric power engineering design. Without superior reconnaissance, there will not be superior design; neither will we be able to shorten construction time, lower engineering costs, raise engineering quality or improve investment results.

The reconnaissance units of institutes directly subordinate to the Bureau must progressively develop in a way that is businesslike and socialist and promote technical and economic contract systems across the borad. They must gradually become command systems for reconnaissance production and economic entities that complete all command tasks and contracted tasks for which they are responsible using entities autarchy for carrying out independent accuating and for assuming responsibility for their own profits and losses. All design institutes and reconnaissance units undergoing structural reform and that are undergoing enterprise consolidation to check if they are up to standard, may refer to the experiences of other concerned units to further develop.

The reconnaissance units of institutes directly subordinate to the Bureau may develop into reconnaissance companies. A company must have a lean administrative organization, must meet the needs of technical and economic management, must have a complete specialized production organization, must establish and perfect a specialized workforce and so divide up the different tasks handed down by the special contracting company.

The reconnaissance companies must give top guarantees of completion for reconnaissance missions contracted as part of key national construction projects. At the same time, they must actively participate in inviting bids submitting bids and carrying on the prospecting tasks and technical consulting assigned to other departments and regions. Thus we both must bring out the superior qualities in the ranks of water resource and hydroelectric power reconnaissance and we must undertake technical development, broaden the sphere of business management and increase our connections.

Reconnaissance companies assuming new missions should get their authority from the concerned unit; after both sides have come to agreement, a formal economic and technical contract should be signed. Within the

reconnaissance companies, there should also be contracts for individual specialized disciplines. Income for reconnaissance work on a particular engineering project could be divided up according to contractual provisions. The Bureau is currently establishing unit pricing and calculation methods as well as quotas for the quantity of control work for all stages of reconnaissance work. Every institute must also strengthen its basic work in management and administration; including quota work and statistical work, and so ensure a more scientific basis for the technical and economic responsibility system.

Every institute should follow the temporary provisions issued by the State Council concerning autonomy for state-run industrial enterprises; they should streamline government and release more power; they should allow the reconnaissance companies autonomy in the management of technology and in management and administration. The institutes should act in the spirit of the provisions in enacting concrete measures.

Bonuses for reconnaissance personnel must be pegged to the size of their contributions; those who make large contributions should receive large bonuses; units or individuals who incur loss through delay of the work, or who blindly increase the amount of work done, or who show lapses in quality, should take a cut in their reconnaissance fees, bonuses, or should be dealt with through other means.

In reforming we must change the system of employment of labor; we should make more use of contract labor, temporary labor, and in principle no longer recruit regular employees, and so lighten the load carried by enterprises. As for separations and retirements, preferential policies should be made for those who can return to their old home and settle back down; separating and retiring personnel should be encouraged to return to their old homes.

III. Strengthen Quality Management

Geological reconnaissan-e units must be responsible for the quality of the data produced by their reconnaissance work. "Quality is number one" is the religion to be practiced with the workers. Quality management systems must be created and perfected. We must gradually promote comprehensive quality management and continually raise the quality of reconnaissance achievements. We must earnestly pay attention to drawing up a broad outline of reconnaissance work based on the demands of the contract project. Each link in the chain of quality management such as the assignments of prospecting work, the acquisition of primary data and the analysis and arrangevent of final data must be carried out on the basis of a broad outline. The outline for geological reconnaissance work should take into account the topography of the worksite, geological conditions, the plan embodied in the project, design concepts and provisions that are in accord with the scope of regulations and the outline must satisfy the demands of the contract. Assignments to do geological reconnaissance work should be made after analyzing the data that is already available and based on

topographical and geological conditions, we must integrate engineering characteristics, comprehensively utilize every reconnaissance technique and arrive at a rational basis for assignments with a clear goal. On one hand we must guard against conservatism in technology, as well as one-sided quests for more work which results in waste; and on the other hand, we must guard against reducing the amount of work done down to the point that it affects the quality of reconnaissance achievements. Primary data must be taken at the site, in accord with the requirements of the concerned rules; it should be recorded right away, collated and put in order, with no losses or arbitrary changes. Cases involving lost, damaged, or fabricated data must be ferreted out and responsibility fixed. The resultant data must faithfully reflect reality, and must accomplish these goals for the chief geological engineering problems: solid theoretical footing, thorough analysis, consistent point of view, rational selection of parameters, correct conclusion; no major geological phenomena can be overlooked, no major geological question can be incorrectly appraised.

Reconnaissance units must establish and perfect quality control standards and systems for inspection and acceptance as well as careful inspection of reconnaissance results and data. Quality inspection and acceptance must be used for every item of reconnaissance engineering work done. We must support self-inspections and mutual inspections of primary data. Results and data should be checked item by item based on the grade of the product and in accord with the technical responsibility system. Every special reconnaissance project that is contracted must be earnestly inspected, checked and accepted against the results and data as stipulated in the contract. Reconnaissance units must organize mutual inspections of engineering quality reconnaissance reports for contracted projects. In order to solve complex reconnaissance technology problems or major geological engineering problems, special discussions should be organized or advice should be sought from specialists with engineering experience.

Every institute must start a movement to encourage excellence in reconnaissance work, establish measures to encourage excellence in reconnaissance work, and standards for excellence in reconnaissance engineering. Every reconnaissance unit must integrate their own specific circumstances to draw up concrete methods, and so ensure the thorough and sustained development of the "encourage excellence" movement.

IV. Promote Technical Advances, Raise the Level of Reconnaissance

A key link in the continual improvement of the level of reconnaissance is the positive selection and development of the use of state of the art technology. The reconnaissance units directly subordinate to the Bureau must pay special attention to scientific research and technical advances and draw up a feasible plan for the import of new technology and the development of scientific research and technology. Based on

the requirements of the technical developments and appropriate reforms of the last few years, the Bureau and the Water Resource and Hydroelectric Power Planning and Design Institute ("Hydro Design Institute") have begun to revise the standards for geological reconnaissance, with 1986 as the target date for completion. At the same time, they have also started to work on revising the rules governing pressurized water experiments and lithologic experiments, as well as internal reorganization, and have also revised and expanded the rules for water quality analysis and appraisal.

Complete use must be made of remote sensing technology, geological maps in every scale must be drawn and geological investigation must be carried out. An aerial survey group should be established quickly, to draw up plans, to coordinate tasks and to do the work for small and medium scale remote sensing geological mapping for every river drainage program. Every reconnaissance unit must set up a remote sensing team, integrate their own work and develop large and medium scale remote sensing mapping. Geological personnel should continue to learn the simpler surveying techniques using devices for in situ surveying as well as photographic and television techniques to be used inside boreholes. They should collect every sort of teological data and parameter and substantiate and determine the value of the data. In addition, Electromagnetic recording devices, video and sound recording equipment and cameras and electronic computing devices must be well utilized also.

In the field of borehole exploration, there must be continued expansion of the use of small-diameter diamond drill head technology. Starting wtih the fact that 70 percent of our borehole exploration teams have already put this technology in force, we must make a push to expand the technology to all drill rigs before 1985, so that all borehold exploration teams will be able to master this technology. At the same time, we must study and expand the use of liquid-driven impact-revolving drilling technology, and directional and rope core sampling drilling technology, as well as every type of coring and sampling method. We must develop pressurized water tests and pressure measuring instruments, and the whole set of equipment for borehole technology parameter control, to further progress in perfecting small diameter diamond drilling technology. In addition, we must pay close attention to testing drills and sampling equipment for overburden strata, to solve the problems associated with drilling and sampling in overburden.

The aerial surveying and surveying specialties must work on steadily developing aerial photographic surveying, progress from analog mapping to computer aided mapping, and so satisfy water resource and hydroelectric power construction's demand for topographic maps in all scales. Every institute must make progress in utilizing surface photography of principal reatures, thus raising the accuracy and

efficacy of large sacle maps of the more rugged areas. Full use of photoelectric distance measurement must be made in topographic surveying, to increase the speed and accuracy of control surveying.

The physical exploration specialists, who have already reaped definite geological results with new equipment, must continue to increase the use of comprehensive logging technology. In 1985 and 1986 the institutes directly subordinate to the Bureau are to be outfitted with the necessary logging instruments in order to develop borehole logging and collect all types of data. They will also gradually be equipped with digital magnetic recording instruments and microprocessors to improve the geological results of seismic prospecting and electric prospecting. At the same time, work must be done on shallow strata reflectance technology and other scientific research work. Physical prospecting must face the two challenges of detecting the geological conditions and detecting the dynamics of the rock body. From now on, geological reports at every stage should append physical prospecting results.

In the field of rock tests, the actual experience of every institute in using the "Directory of Rock Test Instruments" must be integrated for the development, improvement, and renewal of rock test instruments. We must further promote in situ test technology and the importation of foreign technology and methods for rock mechanics. These should be incorporated into ongoing scientific work. A research methodology appropriate to China's rock conditions should be sought out and firmly grasped.

All specialties, including surveying, physical exploration, geological and rock mechanics, must make more use of computer technology.

When all geological reconnaissance disciplines make use of new technology and new methods to contribute even richer first hand data, there must be a continued effort to raise the level of comprehensive analysis of geological engineering. The geological laws of the area of the engineering project must be grasped and integrated with the intent of the plan; studies of the characteristics of the rock body must be made, and precise engineering geology evaluations and conclusions must be made. The analysis and evaluation drawn from on site observation and test studies, with the aid of geological modeling and computer technology must provide extremely rich quantitative data for the engineering design, as must the use of in situ testing for monitoring and verification.

In order to continually push forward technological advances and promote the use of new technology, it is necessary to constantly supplement and revise rules and standards as well as technical provisions. "Requirements for the Depth and Quality of Geological Reconnaissance Work at Every Stage of Reconnaissance and Design" is a supplement to "Geological Reconnaissance Standards." One reason for it was to promote intermingling among the disciplines, and to promote the use of new technology and methods.

The Bureau and the Hydro Design Institute are further strengthening the leadership of scientific research work, are perfecting all specialized reconnaissance information networks, are strengthening reconnaissance information technology and reconnaissance technology summary exchange work and are organizing different forms of reconnaissance technology in a planned way.

V. Strengthen and Perfect of Technical Equipment for Geological Reconnaissance

The geological reconnaissance units subordinate to the Bureau must gradually be outfitted with and perfect the equipment for production of technical reconnaissance work, based on the need for promoting technical advances and based on the demands of the rules, regulations, and the "Requirements for the Depth and Quality of Geological Reconnaissance Work at Every Stage of Reconnaissance and Design." Every institute must take steps to set up a plan to renew and supplement rock mechanics test equipment, and continue to equip themselves with physical exploration equipment and simplified geological test equipment. Within the next few years they definitely must raise the level of technical reconnaissance production equipment even higher and so meet the needs of the work.

With the advances in the reform of the reconnaissance management system and with the construction of reconnaissance bases, all reconnaissance units, under these new circumstances, must upgrade and equip themselves with work equipment suited to reconnaissance work in the field according to the special characteristics of the livlihood and production of reconnaissance teams. The reconnaissance teams must also be more lightly equipped and more mobile.

There must be scientific administration of-reconnaissance instruments and equipment and there must be rational use. Reconnaissance units must pay attention to purchasing complete sets, and must pay attention to inspection and testing before accepting delivery. Those instruments and guages in use today must be calibrated according to a fixed schedule. We must strengthen and maintain and raise the rate of undamaged instruments and equipment. File cards should be kept on each piece of equipment to better administer all types of equipment.

VI. We Must Strive to Establish a Contingent of Reconnaissance Workers That Is Geared to the Four Modernizations

In order to thoroughly resolve the "long standing" problems, in the geological reconnaissance ranks of the institutes subordinate to the Bureau, we must first reform the administrative system of geological reconnaissance and, second, make thorough changes in the life styles of and the work being done by reconnaissance teams, and establish a rank and file that is geared to the "four modernizations." It is necessary that the rank and file be revolutionary, modern, specialized, and have

their equipment made lighter, before they will meet the needs of either reform or the requirements of water resource and hydroelectric power construction. Reconnaissance units must strengthen political and ideological work, so they will be firmly grounded in the four fundamental principles and warmly embrace specialization within reconnaissance, and be willing to contribute to water resource and hydroelectric power construction all their lives. We must gradually establish and perfect a specialized contingent of workers that in every field of reconnaissance work: this will help coordinate our technical strengths, will be of benefit in contract bidding and acceptance, will be of benefit in the integration of production and science, will help in encompassing investigation and solving the issues of engineering geology and will raise the quality of the product of reconnaissance work. There must be a continuous effort to outfit the reconnaissance disciplines with modernized technical equipment, to press forward the advance of technology, thoroughly test the mysteries of nature and produce ever better geological reconnaissance data. Without modernized reconnaissance, there can be no modernized design. A solid new base camp for reconnaissance must be established, with proper measures taken for older, disabled workers and their dependents. The mobility of the workforce and its production efficiency must be raised by simplifying the equipment and goods and materials needed for work and livelihood.

The training and rotational training for reconnaissance workers must be taken firmly in hand. We must be constantly raising their political consciousness, as well as their scientific educational and technical training level. We must use the intervals between busy seasons, such as flood season and the dead of winter, to organize training. In keeping with the requirements of each unit's production work and technical development, we must fix regulations for training work and make concrete arrangements. We must devise separate, clear standards and requirements for nurturing technicians, administrators, leading cadre and laborers. When needed, units may delegate administrators and technical personnel from secondary and post-secondary technical schools to do the training. Through training, we must strengthen the development of knowledge, continually improve specialized training and personnel classification within reconnaissance units and raise the quality of the workforce. We must also carry out specialized training for the abundant number of non-specialized personnel and young workers and then assign them to appropriate work.

We must establish and perfect a system of personal responsibility at every level, implement the policy of "reward the good and punish the inferior" and "reward the industrious and punish the lazy." We must conduct proficiency tests and merit promotions in accord with national regulations, and give special promotions for those who make special contributions; we must root out and take strict measures against those personnel who go against party discipline and national law, or who cause losses at work either through negligence or dereliction of duty.

Building a leadership structure in accord with the goals of the four modernizations at every level in the reconnaissance units is a key issue in the question of whether we can build a workforce that is geared to the "four modernizations." We must be brave in reforming and we must dare to bring innovative young and middle aged cadre into every leadership battle station. As for those cadre who obstruct reform, are incompetent, or who are unable to clear the decks and begin again, we are not free to leave them in leadership battle stations. At every level of administrative and technical leadership we must pay attention to each specialist cadre's suitability to the post. The party committee and the director of every reconnaissance and design institute must take the building up of the workforce to heart, must emphasize the leadership of reconnaissance work, and should have the director or assistant director have direct responsibility for reconnaissance work done. The institute leadership is to have direct responsibility for the building up of the workforce.

VII. Accelerate Construction of Reconnaissance Bases

One measure that is 100 percent required if we are to reform and if we are to begin reconnaissance anew on a clean slate, is the construction of reconnaissance bases; it will rectify the workforce, it will stabilize the workforce and will help eliminate the workers' tendency to look back to the past. All institutes subordinate to the Bureau should proceed in the spirit of the Jinhua Base meeting and must pay close attention to carrying out the program for reconnaissance bases in 1985. The Bureau and the Hydro Design Institute will be contracting the concerned provincial and municipal organizations, and will be raising money for the completion before 1990 of construction of bases for the reconnaissance workforce already in place.

The reconnaissance units must continue to forge a comprehensive package of production, education, training and employee welfare benefits into a basis for construction of reconnaissance bases. This will be both the rear area for and the combat zone for the reconnaissance workforce.

The leadership of every institute must put their hearts into the construction of reconnaissance bases; they must put the construction of the bases and the construction of the workforce at the same level in their thoughts. The bases must satisfy the requirements of production by the reconnaissance workforce and for training the workers; they must also solve the problems of arranging housing, separation and retirement for the workers. Under certain conditions the bases should include the establishment of subsidiary businesses, the setting up of cooperative financing, the organization of labor service companies and welfare service companies to give more opportunities for work to surplus employees and the dependents of employees. Essential rules for the administration work of the bases must be laid down, and this will necessarily involve certain policy issues which must be earnestly studied and thoroughly reviewed at meetings of employee representatives, then rationally resolved.

VIII. Show Concern for Reconnaissance Work, Strenghten Leadership and Management

The leadership of institutes subordinate to the Bureau should show the necessary concern for reconnaissance work in their own units, earnestly strengthen management and leadership, and regard reconnaissance work as the foundation of every reconnaissance design institute. Their chief obligations include: (1) Implement and supervise all national laws, regulations and guiding principles on reconnaissance work; (2) shoulder responsibility for the administration of subordinate reconnaissance organizations, for the construction of the workforce and for construction of bases; (3) make known within the unit all agreements as to reconnaissance missions undertaken, as well as the contractual agreements for organizational and coordinated contract papers signed, and see to it that they are carried out; (4) give impetus to the units' utilization of advanced technology, participate in scientific advances and the digestion of imported technology, continue to push for quality control at every step of reconnaissanye work and start movements for excellence in reconnaissance projects. In order to assure that reconnaissance units are able to raise the level of their technical equipment and to positively support units in solving problems of supply of equipment or material, the leadership should: (5) take responsibility for examining reconnaissance results; and (6) coordinate work responsibilities between reconnaissance sections within the unit and other sections within the unit.

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CSO: 4013/135

HYDROPOWER

REMOTE SENSING TECHNOLOGY AIDS HYDROPOWER PLANNING

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 4, 12 Apr 85 pp 20-25

[Article by Jin Hengding [6855 0077 0002], Ministry of Water Resources and Electric Power's Tianjin Survey and Design Institute: "The Meaning and Function of Promoting the Use of Remote Sensing Technology"]

[Text] I. Current Applications

Remote sensing is a state-of-the-art comprehensive surveying technology that developed along with the rapid and vigorous rise of the aerospace industry in the 1960's. It involves many facets of study and utilization and is developing very quickly. According to the relevant data and reports, 120 nations and areas in the world are already at different stages in using this technology. More than 130 units in China are already at work on the development and study of remote sensing technology, involving several dozen professions in every area of the country. Some starts have been made in the area of water resources and hydroelectric power. According to incomplete data, 45 water power and hydroelectric power exploration survey projects involving 14 units are currently under way using this new technology. See the table below for particulars.

Use of Geological Remote Sensing in China's Water Resources and Electric Power Projects

#	Project Name	Unit in Charge	Satellite 1		Aerial				1	Surface		
			(1)	(2)	(3)	(4)	(5)	(6)	(2)	(3)	(4)	(5)
01	Nanshui Beitiao West Line	A	+	+					+			
02	Xiaolangdi Reservoir	A	+	+								
03	Huang He Mouth	A	+	+								
04	Nanshui Beitiao Middle Line	B	+	+								

[continued on following page]

		(1)	(2)	(3)	(4)	(5)	(6)	(2)	(3)	(4)	(5)
05 Chang Jiang Sanxia Power Station	B	+	+	+	+		+				
06 Danjiangkou Conservation Project	B	+									
07 Pengshui Conservation Project	B							+			
08 Goupitan Power Station	B	+	+								
09 Geheyan Power Station	B	+	+					+			
10 Guishan He Power Station	B	+	+								
11 Tongting Hu Plan	B	+	+								
12 Zhaolian He Conservation Project	B	+	+								
13 Xi Jiang Plan	C	+	+					+			
14 Dengzhou Conservation Project	C	+	+					+			
15 Panjiakou Reservoir	D	+	+	+	+			+	+		
16 Wanjiazhai Power Station	D	+	+		+	+		+		+	+
17 Longkou Power Station	D	+	+		+	+					+
18 Nantianmen Reservoir	D	+	+								
19 Zhang He Plan	D	+									
20 North China Plain	D	+				+					
21 Shisanling Reservoir	E	+	+		+						
22 Lubuge Power Station	F	+	+								
23 DachaoshanF Power Station	+	+									
24 Sijiacun Power Station	F	+	+								
25 Manwan Power Station	F	+	+								
26 Xiaowan Power Station	F	+	+								
27 Tianshengqiao Power Station	F	+	+								

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		(1)	(2)	(3)	(4)	(5)	(6)	(2)	(3)	(4)	(5)
28 Yalong Jiang Plan	G	+	+	+	+	+					
29 Ertan Power Station	G	+	+	+	+	+			+		
30 Dagangshan Power Station	G								+	+	
31 Tongjiezi Power Station	G		+								
32 Jinping Shui Power Station	G			+	+	+					
33 Yangzhuoyong Hu Power Station	G								+		
34 Min Jiang Plan	G				+						
35 Longyangxia Power Station	H	+	+					+			
36 Laxiwa Power Station	H	+	+								
37 Lijiaxia Power Station	H	+	+								
38 Hunanzhen Power Station	I	+									
39 Manjiang--Songjiang Canal Plan	J	+	+								
40 Hongxhui He Plan	K	+	+								
41 Fengtan Power Station	K	+	+								
42 Wenyu He Drainage Plan	L	+			+						
43 Jiaochengxian Conservation Plan	L	+			+						
44 Sanjiang Plain Conservation Plan	M	+	+								
45 Xinlicheng	N	+	+	+	+	+					

N. B. A "+" indicates that remote sensing methods and data have been used in the geological survey of the respective project

Key:

A=Huang He Commission, Design Institute
B=Chang Jiang Drainage Plan Office, Design Institute
C=Zhujiang Commission Survey Team
D=Tianjin Survey and Design Institute
E=Beijing Institute and Tianjin Institute
F=Kunming Institute
G=Chengdu Institute
H=Northwest Institute

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Key [continued]

I=East China Institute
J=Northeast Institute
K-Guangxi Institute
L=Shanxi Institute
M=Heilongjiang Institute
N=Jilin Institute

(1) Multiple wave length scanning
(2) Visible spectrum photography
(3) Multiple wave length photography
(4) Infrared color photography
(5) Infrared scanning
(6) Side-looking radar

An analysis of the table shows the following:

1. The ratio of developed projects which used remote geological sensing to remote sensing projects which are currently in the survey stage is very low. China began using remote sensing techniques around 1975, so the ratio of remote geological sensing projects per year is even lower. This state of affairs shows that the application of remote sensing technology to China's water resources and hydroelectric power is still limited to a small number of projects in the survey stages, there are still large gaps between it and commonly used technology and we must work harder to catch up.

2. Not many units are developing the utilization of remote geological sensing. The explanation for this is that only units of the Ministry have set up organizations to utilize remote sensing; not even one unit of the provincial institutes has established this type of organization. It may be that some units which have developed remote sensing work have not had their work recognized, and fall into the "locally run" or "spare time" categories, making the work extremely difficult. How to bring these positive elements directly and systematically into play in production oriented utilization is a question that must be faced by leading sectors. This will be an important step in the promotion of the development of remote sensing.

3. The ways in which remote sensing is used are still fairly limited. In the last few years there have been ten different remote sensing methods developed in water resources and electric power projects, but in most applications only satellite and aerial black and white photography is used. The other methods are still little used, due to problems with costs, equipment, professional level and data sources.

II. The Prospects for Development

The steps taken in the remote sensing process are roughly these: select a sensing method according to the demands of the mission; do the on-site sensing work; gather the data. Or it might be to put together the previously collected data on an area; do the laboratory optical and computer work; form a geological hypothesis; test it in the field; report the results. Such a complete system of remote sensing work has not yet been developed in China. If we could do so

in the near future, then remote sensing could truly be brought to bear on production. Since everyone is familiar with four of the five steps enumerated above, I will only describe the first, that is, the question of gathering previously collected data on an area.

Remote sensing is usually divided into three types according to the elevation of the instruments above the ground: surface, aerial, and orbital. Since each of these forms an image on a different scale and with different surface resolution, we must chose a method according to the demands of the mission and the phase of the survey. For example: orbital remote sensing can produce a small scale image of a large area, wtih the advantages of low cost, high speed and good repetition; but there are problems with the small scale and the low surface resolution. This type of remote sensing data is best suited to large scale inquiries into water resources and hydroelectric power, such as water resources and hydroelectric power plans, drainage plans, cascade development, hydorgeological investigation, regional geological investigation, structural stability and earthquake geology investigation, reservoir earthquake induction studies, geological investigations of large scale penstock routes, etc. Current water resource and hydroelectric power projects using this type of remote sensing technology for geological data include: geological surveyinf for the Nanshui Beitiao South Line and Middle Line penstock routing project; regional geology and structural stability investigations for the areas of the Longyangxia, Laxiwa, Lijiaxia, Lubuge, Dachaoshan, Sijiacun, Manwan, Xiaowan and Tianshengqiao power stations; reservoir background studies on seismic induction for the Panjiakou Reservoir, the Danjiangkou water conservancy project and the Hunanzhen power station reservoir; as well as 39 other projects including the Xi Jiang plan, the Zhang He plan, and the Hongshui He plan. Experience has shown that if this type of data is used first, the required geological data can quickly and accurately be selected.

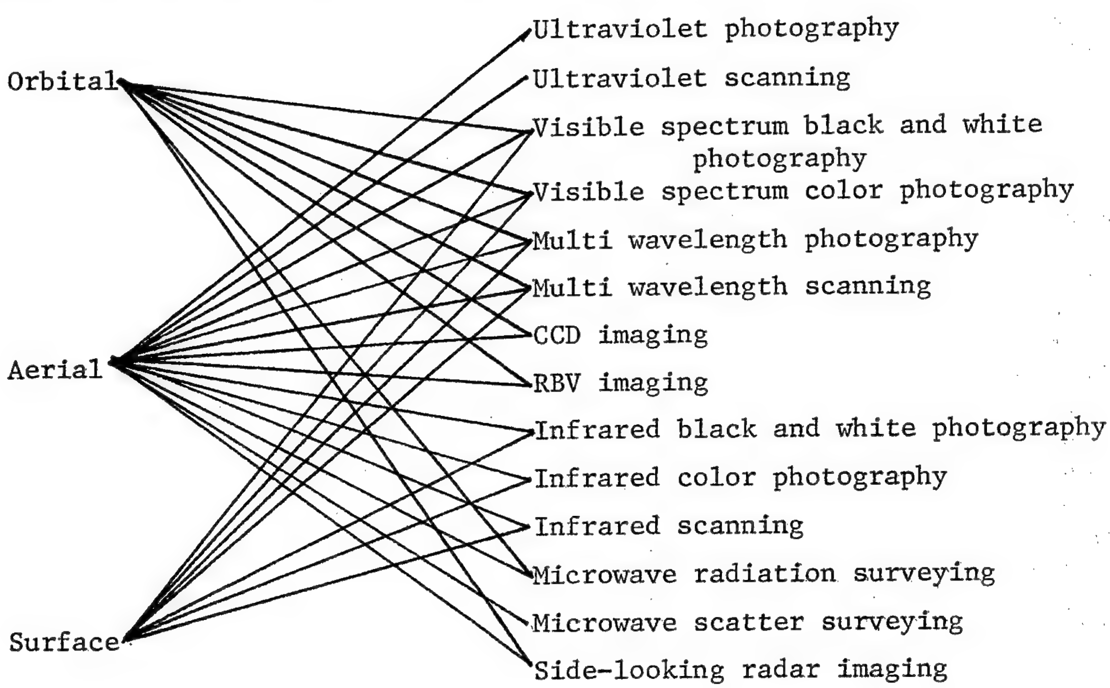
Aerial remote sensing can produce images of mid-scale (1:10,000 to 1:100,000) and of middle scope. This type of remote sensing data sees wider use because the scale is moderate and the surface resolution is fairly high. But when the data is not already available, or when specialized methods are employed, flight time costs are high. This type of data is employed for feasibility studies for water resource nad hydroelectric power construction, for planning programs in the initial stages, for hydrogeological and topographical surveying, geological investigation and construction arrangements. There are presently 35 water resource and hydro power projects going on in China that are using this type of data, including: geological work for the dam and reservoir areas of the Sanxia, Wanjiazhai, Longkou, Ertan and Jinping power stations; the Panjiakou, Xinlicheng, Shisanling and Nantianmen reservoirs; and for the Zhaodong He and Dengzhou key water conservancy projects. Also included are the Yalong and Wenmin He plans, landslide investigations for the Tongjiezi and Longyanxia power stations, etc. We can see from the uses of aerial remote sensing that fairly good results are achieved on most projects.

Surface (earth or water surface) remote sensing is appropriate to geological investigations of smaller scope, and can produce images of large scale and high resolution for a small area. Its shortcomings are that it is susceptible to various natural conditions and the scale shows great fluctuations. This sort of data is appropriate to the initial design steps of water resource and hydro power construction, making detailed drawings for construction projects and partial terrain surveys for construction projects in progress, for geological investigation, for base pit investigations, special studies and observing trends. There are 19 projects using such data currently underway in China, including: the landslide studies and border area stability studies for the Ertan, Dagangshan and Yangzhuoyong Hu power stations; and large scale map-making for the Wanjiazhai and Geheyan power stations and the Pengshui key water conservancy project. The geological results are normally hard to duplicate using ordinary work methods.

All three of the above types of remote sensing technology are appropriate to water resource and hydroelectric power engineering surveys, particularly aerial and surface data which find widespread application.

The use of remote sensing technology necessarily involves the selection of sensing equipment. There is a large variety of such equipment already developed and new types are constantly under study. These sensors may be distinguished by the different types of carrier they are mounted in. The relationship between certain types of sensor and the carrier vehicle (sensor platform) is described in the following figure:

Remote Sensing Platforms and Some of the Instruments Installed on Them



Of the various types of photographic, scanning, measuring and side-looking radar sensing devices included in the figure, each has its special characteristics and can be directed at the demands of varying geological conditions and working conditions. For instance, aerial infrared color photographic data was used for the geological survey work at twelve sites, including Sanxia, Ertan, Wanjiazhai, Longkou and Panjiakou. The results were a cut above the data obtained through regular means.

This demonstrates that there is a bright future for the use of remote senging technology in water resource and hydropower engineering geological surveys. We presently have a variety of photographic, scanning, and imaging sensors available, important in the detection of conditions on the earth's surface. Microwave and side-looking radar can be used for detection to a shallow depth beneath the earth's surface, and this is an area of remote sensing that will be more developed in the future. Infrared scanning has perhaps the most numerous applications in water resource and hydropower engineering survey work. Thus, if one merely understands the capabilities of various sensors and selects the correct sensors and sensing methods for the job, one may produce useful data ahead of schedule.

III. The Meaning and Function of the Promotion of the Use of Remote Sensing Technology

A. It Allows Us to Better Carry Out Scientific Procedure of Geological Work from the General to the Specific

The "Standards for Water Resources and Electric Power Engineering Geological Surveys" (SDJ14-18), general standard, section 4, states: "Every stage of engineering surveying must be done in accord with the demands of the mission, proceeding from the general to the specific, integrating the general and specific, proceeding from the surface to the principles below the surface, getting a grasp on important geological questions, working in accord with local conditions and comprehensively using every sort of survey method." This is to say, on the basis of understanding regional geological conditions, we must then progress with the geological survey work for the dam area, thus guarding against any major geological question slipping through the cracks and avoiding untoward influences on the engineering work. To this end, a large number of projects in the past have started out by either gathering available geological data, or sometimes by doing a traverse survey, in order to fulfill the mission of investigating the surface. But this is often less than ideal. The main reasons for this are a lack of first quality data and a lack of perception; and the regional and structural sections of many units' geological reports take their data from other units' work. Thus our great geolotical workers early on demanded to do their own regional geological survey work, but very often, because of demands of the mission and a lack of time and personnel, it was hard to do this. Remote sensing has now simplified conditions for us, and

we may use remote sensing data to explain and analyze regional geological structural characteristics and quickly produce first rate data. For example, 5 units have been at work constantly on the work for the Wanjiazhai power station on the Huang He ever since the 1950's, and as late as 1979, their geological reports held that the "dam was situated on the north limb of the Laozhaoshan anticline." However, when in 1983 the Tianjin Institute of Surveying and Planning used remote sensing imaging to interpret the geological conditions, we first observed that the main structural line of this region strikes from north to east, while the Laozhaoshan anticline strikes east to west; shortly thereafter we found that Carboniferous strata are distributed on the axis of the anticline, while Cambrian and Ordovician system strata are distributed on the limb in the Wanjiazhai dam area. This phenomenon of an anticline with new strata on the axis and old strata on the limbs is contrary to structural geological theory. Thus we reached a new understanding, somewhat different than our old one, and field work confirmed that the interpretation based on remote sensing was accurate, and has been generally accepted. Similarly in the study of the Danjiangkou reservoir earthquake induction problem, the Chang Jiang Drainage Plan Office used the interpretation of remote sensing images to reach the new conclusion that in the reservoir area the north to west striking faults are the most developed and the faults striking south to north are actually not very developed.

B. It is a Good Way to Improve Geological Work Methods

For a long time water resource and hydropower engineering geology surveying used geological point and traverse observation methods. This method required a long period of field work to fill up a map point by point with geological data. It was difficult, painful work and was easily susceptible to natural influences. It was hard to make observations in hard to reach places. Obviously when the season was very cold or rainy, it was best to suspend outdoor work altogether. To continue to use this method would adversely affect the development of China's water resrouce and hydropower construction. Our construction methods are now mechanized, and we now use computer assisted design; what a contrast to the geological worker scrambling up a mountain on his own two feet. In our plight it is imperative that we rapidly develop and utilize remote sensing technology, and changer our traditional geological work methods. We feel the following applications of remote sensing could be put to work now:

1. Remote sensing can be used in the compilation of survey plans and of survey mission documents. Topographical maps are important in the making of survey plans and survey mission documents. Remote sensing photographs provide rich topographical detail. The use of this type of data in making survey plans and survey mission documents, assigning survey work and arranging survey routes would be better suited to actual conditions. For instance, at the Ddngzhou key water conservancy project, aerial photographs were used to plan the line of the dam and the location of drill holes, which allowed the dam to be sited on good solid rock and avoided weak rock and contact zones.

2. In geological map making. Remote sensing technology can be used to make maps of all types and of various scales, greatly reducing the time used by field work. According to our understanding, there are 18 projects going on in water resources and hydroelectric power which use remote sensing data for map making, ranging in scale from 1:1,000,000 to 1:500, and in various types including regional geological, bed rock geological, engineering geological, hydrogeological and dam site elevation maps.

3. In hydrogeological survey work. More information can be provided for hydrogeological survey work through the use of remote sensing than can be provided by surface survey methods. The hydrogeological zone maps for the Xinlicheng reservoir and the Jinyuetan reservoir were made from remote sensing data.

4. In the study of special topics in engineering geology. In the construction of large scale water resource and hydroelectric power projects, there are always some major geological questions which require special investigation, such as karst development, the outlets of underground rivers, distribution of underwater springs, distribution of the buried beds of ancient rivers, the conditions involved in the flooding of reservoirs, leakage of reservoirs, the immersion of reservoirs, leakage of water channels, leakage of coffer dams, stability of the banks, and collapsing of reservoir banks, structural stability, earthquake geology, reservoir earthquake induction, etc. Practice has shown that remote sensing yields rather good data for the study of these questions.

5. In water resource and hydropower plans. The scope of planning work is large and there is a great deal of substance which place large demands on geological work. This creates a vast potential for the use of remote sensing. Recently the plans for the Yalong Jiang, Xi Jiang, Wenyu He, Sanjiang Plain, Tongting Hu, Nanshui Beitiao and Huang He Diversion have all used remote sensing data.

6. In engineering geology investigations for routing tunnels and chambers, penstocks, power lines, railways, roads, etc. The roads and routes to water resource and hydropower construction projects range from 20 kilometers to several hundred kilometers long, and at times it is necessary to reach areas which have complex geology and difficult natural conditions. Here remote sensing technology will show its clear superiority. The Nanshui Beitiao middle route and west route projects are using remote sensing data to make their maps.

7. In finding natural construction materials. Water resource and electric power construction uses a great deal of natural construction materials. Their quality and their distance from the dam site has a profound influence on the type of dam construction that will be employed, and on the cost of construction. Remote sensing allows us to quickly determine the quality and distribution of natural construction

materials in the vicinity of the construction. For instance, in the Tengchong region of Yunnan, remote sensing images showed that in areas of granitic and metamorphic rock, soil materials were scarce, but in areas of limestone and basalt rock, there is a great deal of soil materials.

8. In confirming previously collected geological data. Water resource and hydropower survey work is never a job that is finished on the first pass; many projects involve a constant turnover, changing personal many times, or collating data collected by various concerned units. All this requires field confirmation of the work, and remote sensing will greatly cut down on the time spent in the field.

9. In investigative and consultative work. The scope of water resource and hydroelectric power engineering survey work is large, and requires a long time; but investigative and consultative work must often be done in a short time, and this is a contradiction that must be recognized. Remote sensing data provides investigative and consultative personnel with images they may look at directly, which is convenient and cost-effective. Aerial video tape, aerial *infra-red color photography and aerial *infra-red scanning were all used for the Wanjiazhai power station; geological video tape was used for the Yalu Zangbu Jiang and Dadu He drainage programs. All methods provided convenient and useful data.

10. In the observation and analysis of trends. There are many aspects of water resource and hydropower engineering surveys, such as the collapse of reservoir banks, border slope stability, landslide activity, reservoir immersion, etc., that require long term observation before the correct conclusions can be drawn. Remote sensing can quickly and accurately provide data on trends, so that measures may be taken in time to deal with them, and accidents can be prevented. Remote sensing was used in observing landslides in the headwaters of the Longyangxia and Ertan power station projects.

11. In the analysis of geological theory. A characteristic of water resource and hydropower engineering survey work is that the work must be very precise even though the geological conditions are complex. This requires a precise theoretical analysis before conclusions fitting the actual conditions can be drawn. Remote sensing imagry can provide reliable support to theoretical analysis. For example, at the Lubuge power station, the Kunming Survey and Design Institute, using remote sensing data, found that the area is on a vortex structure, and is not the junction of three faults (striking north to east, east to west and north to west respectively) as was previously supposed.

C. Remote Sensing Will Speed Up Engineering Surveying and Cut Down on Expenses

Everyone knows that surveys using remote sensing technology are fast, and that data is quickly collected. The use of remote sensing technology will greatly reduce the amount of fieldwork required and lighten

the difficult work load our great geological workers must bear. It will raise our work efficiency, raise the accuracy of data, and save money. The Soviet Union used remote sensing in compiling their 1:200,000 geological survey, and saved 60-67 percent over the use of conventional methods. The Chang Jiang Drainage Plan Office used remote sensing methods in compiling a 1:50,000 survey for the selection of dam sites in the Qing Jiang Zhaodong He key water conservancy project. They saved 53 percent of the workdays that would have been required by conventional methods, and over 10,000 yuan. The Tianjin Survey and Design Institute used remote sensing methods to make a 1:100,000 regional geological map for feasibility studies for the Wanjiazhai power station on the Huang He. The area covered was 7,000 square kilometers, but it only required four workers for indoor and field work, and only took five months to complete the mission. Ordinary methods would require a whole team to work for a year and a half. The actual cost per square kilometer was about 3 yuan, much less than the 20 yuan per square kilometer cost of ordinary methods. Therefore remote sensing is not only fast and accurate, it also brings definite economic benefits.

D. It Will Eliminate or Reduce the Influence of Natural Conditions

Remote sensing is a method of measurement from a distance, and is not limited by natural conditions or difficulties in transportation. In areas where work is hampered (such as primeval forest, high cold mountain areas, swamps, tundra, glaciers, deserts, coastal zones, tropic rain forests, etc.), remote sensing technology is clearly superior for carrying out geological investigations. Thus it is a technique that would be of benefit to water resource and hydroelectric power geological investigations in the Southwest, Northwest, Northeast, and South of China.

E. It Will Be Helpful in Realizing the Modernization of Geological Survey Work

The methods used by remote sensing far outstrip the capabilities of the human eye. The instruments produce video frequency data, analog data, digital data, imaging, and combinations thereof. Remote sensing technology uses various types of optical instruments and computers to reproduce scanning and imaging. Put simply, the collection, processing and interpretation of remote sensing information, and the making of maps from it, all use the latest in optical and computer equipment. Thus, the adoption and implementation of this technology will not only speed up the development of remote sensing technology, but will put geological work on a heading toward modernization. We may assert that the use of remote sensing technology will riase the curtain on a on the modernization of engineering geology and on a revolution in engineering geology.

IV. Conclusion

Now we must "write the second chapter," and mastering survey work is one important aspect. Transforming the rather backward state of survey work and promoting the use of remote sensing technology is of pressing importance. However, reforming our methods and importing and promoting new technology is not something that is done lightly. It involves a whole series of issues such as sources of funding, personnel training, equipment that must be purchased, testing, promotion of utilization, production plans and the exchange of information at home and abroad. But these issues are too much for a single unit to deal wtih effectively. We propose that the upper ranks of principal administrative sectors establish an organization specializing in the application of remote sensing technology and plan and arrange related matters on an integrated basis, so as to compel this technology to be developed even faster for water resource and hydropower applications and so that we may better serve the mission of the construction of China's water resources and hydropower.

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CSO: 4013/135

HYDROPOWER

STATUS OF EXPLORATION WORK IN HYDRO PROJECTS REVIEWED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 4, 12 Apr 85 pp 34-36

[Article by Duan Wenyu [3008 2429 6877] of the Water Resource and Hydroelectric Power Construction Bureau, Reconnaissance Office]

[Text] With the development of water resource and hydroelectric power construction in China, there has also been a great development in exploration which is regarded as the only measure for directly gathering data on underground geology and for creating the technical conditions for rock body mechanics tests, physical exploration test wells, hydrogeological tests and basic processing and the developments in the last few years have been particularly rapid. This is mainly manifested by the fact that preliminary steps have been taken to replace equipment and technology more advanced technical methods have begun to be researched and applied and have thus spurred on the continuous improvement in the quality of borehole exploration and the staggering increase in productivity. I will discuss below the current state of China's water resource and hydroelectric power engineering geology borehole exploration, then I will make some suggestions and proposals on how to improve future borehole exploration work.

I. Strive to Promote Small Diameter Diamond Bit Borehole Exploration

Small diameter diamond bit borehole exploration is today a rather advanced technology, with the good points of high efficiency and good quality core samples to its credit. It is an effective method of speeding up borehole exploration. In the past few years, water resource and hydroelectric power organizations have greatly promoted the use of this technology, and have achieved outstanding results.

1. It increases the speed of geological borehole exploration. Today, the organizations directly subordinate to the Ministry have basically achieved small diameter diamond bit (hard alloy) borehole exploration in core exploration; and this is a great reform in the area of water resource and hydroelectric power borehole exploration. About 70 percent of the drill rigs in borehole exploration operations use this kind of drill; their annual footage may reach approximately 150,000 meters, and their efficiency if 100 percent better than that of the original iron sand-steel gravel footage. In order to further raise the level of

efficiency and technology of small diameter diamond bit borehole exploration, the concerned units have been conducting research on drilling techniques for solid rock slip faces and the applicability of diamond rimmed bits to them, research on drilling rock initial location test holes, and research on drilling upwards or horizontally out of horizontal tunnels. Definite successes have been reaped.

2. It increases the quality of core samples, providing reliable data for -eological work. Because of the increased use of diamond bit borehole exploration technology, important action has been brought to bear on the improvement of the quality of rock core samples. Coring efficiency is about 95 percent in fairly intact strata, and there are clear improvements in complex strata. For instance, the Northeast Reconnaissance and Design Institute, in the borehole exploration work for the dam site for the Datengxia hydropower station, encountered gently dipping intercalated strata; using small diameter diamond bit borehole exploration methods, they drilled to 700 meters, retrieving 1,093 soft intercalated core samples, with an average core recovery efficiency of 93 percent. Most interesting was the data on layers turned to mud (figure 1). By way of comparison, another unit drilled in the same area in 1959, using the iron sand-steel gravel method. They reached down to 1,620 meters, with a core recovery efficiency of 58 percent, while they left no record of data on intercalated strata. The Chengdu Reconnaissance and Design Institute, while working in gently dipping pancake granite also produced high quality core samples (figure 2). The Huang He Committee Design Institute was successful in studying a special diamond sleeve core sampling technology. In addition, the Chengdu Reconnaissance and Design Institute has used diamond drilling in granite with well developed jointed fissuring; their rock core sample recovery efficiency was above 90 percent (figure 3). The Northeast Reconnaissance and Design Institute has used the diamond drill rope core method, which allows continuous drilling without raising the drill head. Used in a thick fracture zone with strata collapsed into cavities, they achieved high quality core data (figure 4).

The above mentioned improvements in stratagraphic core sampling, have lead to the poor data gathered in the past all basically being corrected, giving a more reliable basis for the study of sites for large dams. In the future, it remains for us only to continue to use new technology in order to attain even more satisfactory results in core recovery from complex strata.

II. New developments in Borehole Exploration Technology for Hydropower

In the last two years there have been more new developments in hydro power borehole exploration technology, and these have met with positive success. Examples are:

(1) Rope coring borehold exploration technology has become more wide-spread and put into play. Practice has proven that it is not only suited to deep hole borehole exploration, it is also suited to fractured

collapsed strata and soft, weak, intercalated beds. Its drilling footage and core quality is generally better than other methods.

(2) Our Ministry has met with success in the first testing and developing of continuous coring equipment which avoids raising the drill head and uses pressurized water test pigs. This has created the condition to spread this technology in hydro power borehole exploration.

(3) Liquid driven percussion-revolving rock coring borehole exploration technology is continuing to find applications. In rock strata of hardness 8 or above, this technology has a drilling efficiency of 46 to 84 percent higher than that of conventional diamond drill techniques.

(4) The study and application of diamond drill head drilling in brecciated strata has advanced rather far, this will raise the quality of samples taken from brecciated strata, and have an important effect on drilling efficiency.

(5) New developments have come through the study of core sampling technology for complex bedrock strata, for examples three layer alarm device, diamond double tube hollow bottom reflecting shield ring, directional and sleeve drilling core sampling.

(6) Studies of reverse vertical hole drilling have been successful, and it has been put into application. This makes for more accuracy in perpendicular drilling for long term observation of positional deformation for dams and foundations.

(7) Definite progress has been made in studies of samples of sand strata and loose mude strata in their pristine state.

(8) Study and development of large diameter vertical shaft (above 1.2 meters in diameter) borehole exploration equipment has basically been successful, and prototypes are in use in vertical drilling, which creates favorable conditions for the engineering geology problems of drilling deep vertical shafts and for direct observation of the bases of dams.

(9) The development of pressure measuring instruments for borehole pressurized water tests has progressed fairly well, and this will contribute to the quality of pressurized water testing.

(10) Fairly good results have been achieved from the use of comprehensive reconnaissance within the borehole, including positional measurement of underground rock mechanics, comprehensive physical reconnaissance wells, borehole television and photography, inclinometers, etc.

III. Renovation and Development of Borehole Exploration Equipment

Engineering geology borehole exploration for water resource and hydroelectric power began in the 1950's with 20 drilling rigs as its foundation. Later, the "hand-operated" type with iron sand-steel gravel (hard alloy) became the principal type among the 100-plus rigs employed in borehole exploration. Today borehole exploration equipment has essentially been modernized or replaced, and the "hand-operated" type has essentially become obsolete and replaced by advanced hydraulic drills made in China. Earth drilling has also become mechanized. Our Ministry's Hangzhou Drilling Rig Factory has designed and produced the Dongfeng SGZ-III small diameter diamond bit hydraulic drill rig, definitely a state of the art device, as well as lightweight high pressure variable flow water pumps, which are very much in use in water resource and hydroelectric power engineering geology borehole exploration work.

We have begun to equip units with such equipment as rope core sampling equipment, borehole directional coring equipment, borehole rock body mechanics measuring equipment, borehole television, inclinometers and comprehensive physical reconnaissance equipment.

IV. Ideas for the Development of Water Resource and Hydroelectric Power Borehole Exploration Technology

1. We must continue to renew and replace borehole exploration equipment. Now and in the future, old and worn out drilling equipment must be replaced in a timely manner in order to ensure the quality of the equipment. This will also ensure a positive attitude toward importing advanced borehole exploration equipment and ensure that the work of renewing and replacing is taken seriously. In addition, the problems of making equipment lighter and more portable are perennial factors which affect borehole exploration, and should be solved once and for all. Now and in the future, a definite number of motor vehicles must be supplied to geological reconnaissance teams for the transport of equipment and supplies, and thought must be given to providing helicopters when work conditions are difficult or normal transport lacking. This would greatly shorten the length of time taken by the work of borehole exploration engineering.

2. Borehole directional coring is a rather effective way of studying the morphology of underground geological structures, and is a new technology for borehole exploration. Use of this technology could reduce the amount of work required for borehole exploration. The use of this technology for water resource and hydroelectric power engineering geology and borehole exploration must rapidly be made more widespread.

3. We must actively promote the use of rope coring borehole exploration technology; this is a new route to improved borehole exploration quality and efficiency.

4. The foundation for the changed face of water resource and hydroelectric power borehole exploration is small diameter diamond bit drilling; great effort should continue to be placed in its further development, while at the same time we must continue to study the problem of raising the level of its operating technology.

5. Brecciated strata are a major problem for engineering geology and borehole exploration; we should make a technological attack on the problem, and already some progress has been made in studies. I suggest the concerned sectors give it sufficient attention, so that a solution can be found as soon as possible, and the solution can be used in production.

6. We must continue to do research on core sampling in soft intercalated strata, fractured strata, and loose strata. We must also continue the study of new types of drilling tools which allow samples to be taken in their original state.

7. We must use the parameter instruments and microcomputer technology for borehole exploration, develop this technology in a new direction, and beginning today, create the conditions for the use of this aspect of technology.

8. Borehole exploration is a multiple disciplinary specialty. Attention must be paid to the nurturing of human potential and investment in learning. This will foster conditions favorable to the progress of technology. I suggest that secondary and post-secondary institutes under the Ministry institute hydroelectric engineering geology borehole exploration classes, and in addition to training a fixed number of borehole exploration technical personnel, that they see to it that in the near future all drill rig chiefs and section chiefs attain the cultural level of secondary school graduate, and all team leaders achieve the level of post-secondary graduate.

9. We must utilize and positively develop comprehensive borehole exploration; this is a method of improving the results of geological exploration. In the near future, every geological reconnaissance unit should be supplied with equipment for physical exploration test wells, equipment for rock body positional mechanics studies, inclinometers and televisions.

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CSO: 4013/135

THE ROLE OF SURVEYING AND MAPPING IN HYDROPOWER DEVELOPMENT

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 4, 12 Apr 85 pp 36-37

[Article by Zhao Yuanchang [6392 0337 2490] and Mao Liang [3029 5328], Water Resource and Hydroelectric Power Bureau, Reconnaissance Office: "The Circumstances for Developing China's Water Resource and Hydropower Mapping Technology"]

[Text] Since the founding of our nation there have been a great deal of accomplishments in the field of water resource andhydroelectric power surveying in the service of water resource and hydroelectric power construction. According to incomplete data, 90,000 kilometers have been surveyed at levels 1 or 2 of accuracy; 290,000 have been surveyed at levels 3 and 4. The following topographical maps have been completed: 13,300-plus square kilometers at 1/100,000; 300,000-plus square kilometers at 1/50,000; 430,000-plus square kilometers at 1/25,000; 1.11 million square kilometers at 1/10,000; 49,000-plus square kilometers at 1/5,000; and 15,000 square kilometers at 1/2,000 and even larger scales. The survey results and completed maps have contributed reliable data for the construction of hydropower stations, reservoirs, flood prevention projects and sluicegates. In the course of 30 years, our technical abilities in survying and mapping have constantly been on the rise, and the technical level has also risen. Based on our present abilities in surveying and mapping, and measured against the future work of units subordinate to the Ministry, we should be able to complete 1,500 large-scale maps per year and survey 1,500 standard square kilometers per year; basically this will meet the needs of water resource and hydroelectric power construction. It is worthwhile to point out at this time that in order to effectively promote progress in China's water resource and hydroelectric power surveying and mapping, the principal concerned sectors in the early 1980's set forth directions for development in technology; photographic surveying was first, and in addition to surveying there were the use of electromagnetic ranging, positive development of computerization, and an increase in the use of remote sensing technology. In the last few years, through the heroic efforts of our great workers, these new technologies have begun to be used to greater or lesser degrees. Continuous improvements have also been made over traditional methods of surveying and mapping, with outstanding results.

I. The Application of Electromagnetic Wave Ranging Technology

With the advent of electromagnetic wave ranging technology, the traditional grid laying method is being replaced by traverse surveys, measured border grids and border angle grids. Under most conditions, the difficult and time consuming baseline chaining is no longer necessary. Accuracy and work elficiency have both risen. The East China Reconnaissance and Design Institute used a DI4L infrared ranging instrument and a T3 transit to do altimetric and transmissability studies for the area between Guanshan Dao and the mouth of the Feiuun Jiang at Rui'an, Zhejiang. The degree of error in the altitude measurement was only ±3 millimeters. This was level 3 accuracy. The Chang Jiang reconnaissance team used a ME-3000 precision ranging device to lay a control grid for a construction project and to do observations of deformation; accuracy was greatly enhanced over that of the past.

II. The Use of Computer Compiling

With the coming of this type of computer, the old fashioned paper and pencil calculations have been done away with, reducing the amount of calculation work, reducing errors and raising work efficiency. To take the classic surveying task of adjusting figures, in the past, one or two days were required, but now it only takes a few minutes. Computer programs for standards 1 to 5 and triangulation, traverse sections and other outdoor observations will all but replace the traditional pocket notebook for field work and also will improve quality. The use of computer technology in the area of surveying field work will bring a great deal of change with it.

III. Aerial Photography and Survey Mapping

Presently, a large part of the water resource and hydroelectric engineering construction projects are using aerial photographic mapping methods, while in areas of scarp and steep cliffs, where surface photography is superior, then surface photography is used for surveying. Aerial surveying is a present day state-of-the-art technique for survey mapping, and when compared to surveyint table methods, it is clearly more accurate, faster, and saves field work. For instance, the section survey for the tunneling at the Luan He diversion project took the Tianjin Rconnaissance and Design Institute Aerial Surveying Team only 34 days to produce 1:5,000 topographic maps for 35 square kilometers. The manpower used would have produced only 1/3 as much using conventional methods. The project was completed 4 months earlier than it would have been using conventional methods. As a result, the Luan He diversion work began earlier than planned. Surface photography has now broken out of the mold of making topographical maps, and has gone on into other fields. The Chang Jiang Reconnaissance and Survey Team used surface photography to measure the speed and appearance of the current when the Chang Jiang wqs dammed at Gezhouba and to measure the degree of leveleness of water coming around the Er Jiang sluice

gates. Both were done with rather good accuracy. The Tianjin Reconnaissance and Design Institute used surface photography to make vertical face geological maps, solving the problem of the dangerously steep terrain at the Wanjiase dam site, a difficult problem for surveying and mapping. These maps, because they involve geological personnel writing geological symbols onto photographs in the course of the indoor mapmaking, have been welcomed by the geological community. The maps have lifelike accurate representation of terrain features.

IV. The Use of Laser Alignment Technology

The use of laser alignment technology to study distortion began at the Fengman dam, and at that time the Northeast Reconnaissance and Design Institute, in cooperation with the Fengman electric plant and Hangzhou University, for the first time successfully installed 200 meter long vacuum wave guide laser alignment system; in 1981 they installed a 600 meter long vacuum type laser dam observation device at the Taipingshao power plant on the Hun Jiang. Now the vacuum guide tube at Fengman has been extended to one kilometer's length, and remote control observation can be conducted from the head of the dam, while at the same time the movement of three benchmarks can be measured with comprehensive accuracy of 5×10^{-7}, a quantitative leap above the levels of other optical methods.

V. The Use of Remote Sensing Technology

The Chang Jiang office, the Tianjin Reconnaissance and Design Institute, the Huang He committee and Zhu Jiang committee have begun to use remote sensing technology and have achieved definite successes. They are in the process of compiling nationwide soil erosion maps to clarify the situation of the loss of soil and water.

While there have been some accomplishments in the field of water resource and hydropower surveying and mapping, yet with the advances in science and technology, the scope of water resource and hydropower construction has become increasingly large, the demands on accuracy are greater and this has brought new demands on mapping and survey work. Our technical level is still not up to that of advanced nations. To meet the demands of turning over a new leaf in the field of water resources and hydro power reconnaissance work, we must begin with a basic foundation of reforms in the system, push for advances in technology, strive for the cultivation of knowledge, actively open up new territories for technical applications and expand the service aspect, so that water resource and hydropower surveying and mapping will continue to develop. Before then, every unit musw begin on the foundation of the technology they have at present, share experience, find shotcomings and, in accord with the geological characteristics facing the unit, the demands of the mission and the actual conditions, they must integrate the key points of technical development, determine exactly what new technology is required right away, establish new goals, set new policies, positively and safely mobilize the work and make every effort to see that their unit makes new progress in surveying and mapping technology.

12663
CSO: 4013/135

HYDROPOWER

BRIEFS

DAHUA UPDATE--Nanning, 8 Jul (XINHUA)--The 100,000 kW No 4 generator of the Dahua power station, a large hydropower station on Guangxi's Hongshui He, was put into operation at the end of June. So far, generator sets with a capacity of 400,000 kW in the first-phase project of the station have all been put into operation. They are able to generate more than 2 billion kilowatt-hours of electricity annually. The second-phase project of the station will be carried out after the completion of the Longtan power station at the upper reaches of the Hongshui He. The total generating capacity after the expansion project is completed will be 600,000 kW, capable of generating 3.6 billion kilowatt-hours of electricity annually. [Summary] [Beijing XINHUA Domestic Service in Chinese 0828 GMT 8 Jul 85 OW]

CSO: 4013/158

THERMAL POWER

BRIEFS

COAL-BURNING GENERATORS INSTALLED--Today, the Changshan Thermal Power Plant held a ceremony celebrating the installation of two 200,000 kW coal-burning generators, and the provincial government's leading comrades cut the ribbon. Changshan Thermal Power Plant is located on the Qianguo grasslands in western Jilin. Construction commenced in 1969, and currently, total installed capacity is 293,000 kW and the generators consume a total of 1,500 to 1,800 tons of fuel oil daily. In order to conserve crude oil and relieve the energy shortage of the northeast power grid, the State Planning Commission approved this expansion of the Changshan Thermal Power Plant. After these two generators go into production, total installed capacity could amount to 680,000 kW. This will play an important role in relieving the energy shortage of the northeast power grid, improving Jilin's power distribution, assisting industrial and agricultural production in Baicheng Prefecture and ensuring that a normal amount of electricity is available to meet the needs of the people's livelihood. At the same time, it can also save 550,000 tons of crude oil and more than 200 million yuan for the state and reduce costs by more than 48 million yuan. The amount of oil and funds saved in 6 months after these two generators go into production could build another 400,000 kW power plant. [Text] [Changchun JILIN RIBAO in Chinese 11 Jul 85 p 1]

TAIZHOU AHEAD OF SCHEDULE--On 12 July at 12:15 p.m., the No. 3 generator of the second expansion project of the Taizhou Power Plant, a key state construction project, after undergoing a 72-hour full load test run, went smoothly into production and was completed 125 days ahead of schedule. Coupled with the No. 1 and No. 2 generators, Tiazhou's installed capacity has reached 375,000 kW, and Taizhou has become Zhejiang's largest thermal power plant. Construction of the No. 3 generator of the second expansion project of the Taizhou Power Plant was started on 15 March last year. According to the state's stipulations for the period of construction, the project was to have been completed by 15 November of this year. The early completion of Taizhou Power Plant's No. 3 generator adds 2 to 4 million kWh to the plant's generating capacity, and this will play a positive role in relieving Zhejiang's current severe power shortage. The No. 4 generator in Taizhou Power Plant's second phase of construction has already entered the installation stage and is expected to go into production by the end of the year. [Excerpts] [Hangzhou ZHEJIANG RIBAO in Chinese 13 Jul 85 p 1]

TONGLIAO PLANT CONSTRUCTION--The first 200,000-kilowatt power generating unit--a part of the first-phase construction of the Tongliao Power Plant in Nei Monggol--was completed and brought into the power grid on 9 June, 52 days ahead of schedule. The Tongliao plant is one of the state key construction projects during the Sixth Five-Year Plan period. Upon completion, it will help accelerate development of the Huolinhe coal field, relieve the strained energy supply situation in northeast China, and develop the economy of Jirem League. [Summary] [Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 13 Jun 85 SK]

TONGLIAO UPDATE--The Tongliao power plant, a state key project, was formally put into operation in Nei Monggol Autonomous Region on 19 August. (Zhang Fengxiang), vice minister of water resources and electric power, and (Zhou Dehai), head of Jirem League, cut the ribbon for putting the power plant into operation. Tongliao Power Plant is a subsidiary project for developing the Huolinhe coalfield. The installed capacity of the first-stage project is 400,000 kW. The first 200,000-kW generating unit was put into operation on 9 June this year, and the second 200,000-kW generating unit is expected to be placed into operation by the end of this year. [Summary] [Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 20 Aug 85]

CSO: 4013/173

COAL

COAL PRICES PLUMMET, CONSUMERS STOCK UP

Wuhan HUBEI RIBAO in Chinese 23 Jul 85 p 3

[Text] Tianjin, 22 July--Vice Minister of the State Economic Commission Zhao Weichen stated recently at a press conference that in the first half of 1985 China's coal supply was ample, the market stable, and reserve stocks up.

Zhao Weichen stated that this year's excellent coal market supply situation is the result of three main factors:

1) China's coal supply has been strained all along, especially in Shanghai, Jiangsu, Zhejiang, and other economically developed regions along the coast, where the coal shortage has been critical. This year, this critical situation has been somewhat relieved and Shanghai's coal stocks have grown to 650,000 tons and some cities have begun to ship coal for winter use;

2) The Northeast, North-Central, East China, and Central China power grids are China's main electricity producing bases. In the past, because of the coal shortage, some of the thermal power plants could stock only enough coal for a few days' production. This year, the nation's four big power grids had stockpiled 3.8 million tons of coal as of the end of June, an increase of 1.25 million tons over 1984. Nationally, the reserve of coal has grown by 5.15 million tons compared to 1984;

3) The unplanned negotiated prices have been falling. Last year, in several coastal cities and provinces, the commodity prices were at a high of 180 yuan per ton. This year, the price has already fallen to around 90 yuan per ton (including shipping costs).

Zhao Weichen added that coal transportation and supply still has some uneveness and that shortfalls in supply and inadequate shipping remain a problem in a few areas.

In conclusion, Zhao Weichen pointed out that according to the experience in 1984, this winter's coal supply and next year's coal supply, distribution, and shipping must be arranged at an early date.

CSO: 4013/176

COAL

SHANXI REPORTS RECORD ANNUAL COAL EXPORTS

OW010810 Beijing XINHUA in English 0639 GMT 1 Sep 85

[Text] Tiayuan, 1 Sep (XINHUA)--China's largest coal-producing center, Shanxi Province, will reach its highest annual coal export figure this year--5 million tons--according to the provincial bureau of foreign economic relations and trade here today.

The figure accounts for more than half of the country's total coal exports planned for this year.

The province produced 187 million tons of coal last year, accounting for a quarter of the country's total.

Shanxi's coal is low in sulphur, rich in varieties, and high in calorific value. The coal has so far been exported to over 20 countries and regions including Britain, France, the Netherlands, Japan, and Hong Kong.

China's largest coal mine, with an annual capacity of 15 million tons, is now being constructed in the northern part of the province jointly by China and Occidental Petroleum Corporation of the United States. With the completion of the mine by 1987, the province's annual coal exports will reach 12 million tons.

CSO: 4010/166

COAL

NINGXIA'S EXPORTS PROJECTED TO TOP 5 MILLION TONS BY 1990

OW201128 Beijing XINHUA in English 1044 GMT 20 Jul 85

[Text] Yinchuan, 20 Jul (XINHUA)--A local official said here today that coal exports from China's Ningxia Hui Autonomous Region will be increased at an annual rate of over 20 percent to reach 1.1 million tons a year in 1990.

According to Ningxia Vice-chairman Wang Yanxin, this is the target stipulated for the region in the Seventh Five-Year Plan (1986-1990).

The region expects to export 200,000 tons of coal this year, 25 percent more than in 1984.

Anthracite produced in Ningxia contains little dust, sulphus, or phosphorus and has high [heat yield]. It can be used in the metallurgical and chemical industries, and for [residential] purposes.

The region plans to excavate 5.1 million tons of anthracite in 1990. Now it is expanding the Ruqigou mine's capacity from 900,000 tons to 1.5 million tons a year, and building a dressing plant with an annual capacity of 2.1 million tons, which will be completed in July next year.

Since 1964, Ningxia has exported its coal to a dozen countries and regions, including Belgium, France, Japan, Malaysia, the Philippines, Britain, the Federal Republic of Germany, and Hong Kong.

CSO: 4020/311

COAL

BRIEFS

QUALITY OF COAL IMPROVES--The Sanlitong Mines Coal Quality Section of the Tongchuan Mining Bureau utilized comprehensive quality management methods, raised the quality of commodity coal, and since the end of 1983, has increased revenue by more than 525,000 yuan. For a long time the quality of this mine's coal was inconsistent and substandard, the ash content was high, the users were not satisfied and the economic results were poor. Starting at the end of 1983, the mine's Coal Quality Section began to use comprehensive coal quality management methods, drew up a chart analyzing the causes and effects of the quality of coal and determined that the main reasons for the low quality of their coal were that the mine allocations were inappropriate, coal and rock were loaded together, the coal being put into storage was not being screened or washed, there was not a timely supply of cars to haul away the waste rock and the system of rewards and punishments was not strict and impartial. After these reasons were discovered, seven measures were adopted to improve the quality of coal: the ash content was lowered 2.22 percent; the percentage of waste rock was 0.26 percent lower than before; and in 1983, the mine received third place in the province's coal mine commodity coal quality management competition, while this year the Provincial Mining Office has recommended that the Sanlitong Coal Quality Section be assessed as an outstanding coal quality management team. [Text] [Xi'an SHAANXI RIBAO in Chinese 12 Jun 85 p 2]

ANTAIBAO UPDATE--On 27 June, the Ministry of Coal Industry informed Beijing reporters of the general situation of the Pingshuo Antaibao Open Pit Coal Mine in Shanxi and of developments in earlier stages of construction. A joint Sino-U.S. effort, Antaibao Coal Mine is designed to produce 15.33 million tons of coal and 6.4 million tons of washed and dressed coal per year, and the total investment is US$640 million. Significant advances have already been made in the early stages of construction, and this has created favorable conditions for formal hauling and strip mining. According to the plans, the mine will go into production in September 1987 and will reach production targets in 1988. As for the form of production, this coal mine will be using the large single shovel and truck plan. The coal washery washes coal using the "heavy medium" method, is automated, has centralized controls, and the dirty water is recycled. The development of the Antaibao Open Pit Mine will play an important role in accelerating the development of China's coal industry, further developing joint ventures with foreign countries and in realizing the modernization of the coal industry. The Antaibao mine is approximately 18.5 square

kilometers in area and has about 500 million tons of coal reserves. The coal seams are stable, quite thick and structurally simple, and the thrid seam which is a major mining seam is a total of 23 meters thick. The type of coal from this seam is gas coal, an excellent source of power. [Text] Beijing ZHONGGUO MEITANBAO in Chinese 29 Jun 85 p 1]

COAL SLURRY EXPERIMENTS--Tangshan, 13 Aug (XINHUA)--China's first experimental center for transporting coal through long-distance pipelines opened on Monday at the Tangshan Branch Institute of China's Coal Mining Research Institute. Coal transportation through pipelines has been undertaken in some countries for nearly 20 years. The center includes equipment for grinding coal, liquidizing it, piping it, and drying it. Government inspectors say it is up to advanced world standards. [Text] [Beijing XINHUA in English 1145 GMT 13 Aug 85]

SHANDONG COAL DRESSING PLANT--Jinan, 31 Jul (XINHUA)--A large coal dressing plant with key equipment and technology imported from the U.S. went into official operation in Shandong Province on Tuesday after passing state tests. Located at the Xinglongzhuang Mine in the Yanzhou coal field, the plant is able to wash 3 million tons of raw coal a year, destined for the Baoshan Iron and Steel Complex now nearing completion near Shanghai. Construction of the new plant, a key state project, took from January 1982 to September 1984. The verified coal reserve in Yanzhou is more than 9 billion tons. The coal field has already developed four pits with a total annual capacity of 5.25 million tons and is building another three with a total annual capacity of 7.6 million tons. According to the state plan, the coal field will be able to produce more than 30 million tons of coal and wash 24 million tons annually by the turn of the century. [Text] [Beijing XINHUA in English 1922 GMT 31 Jul 85 OW]

ANHUI MINE DESIGN BIDDING--Beijing, 14 Jun (XINHUA)--The Hefei Coal Mine Design Institute today won the bidding to design China's largest coal mine. The Guqiao Pit in Anhui Province's Huainan Coalfield is to produce 10 million tons a year. Reserves of high-grade coal are put at 2 billion tons. Four institutes put in bids to the Coal Ministry. This is the first time a pit design has been put to tender in China. [Text] [Beijing XINHUA in English 1244 GMT 14 Jun 85]

CSO: 4010/161

PRODUCTION, ONCE FALLING, NOW UP IN HUABEI OIL FIELD

OW121639 Beijing XINHUA in English 1626 GMT 12 Aug 85

[Text] Shijiazhuang, 12 Aug (XINHUA)--Crude oil production at China's Huabei oil field in Hebei Province has begun to recover after reporting declining production for 4 years, an official told XINHUA today.

The oil field, China's third largest after Daqing and Shengli, yielded 5.17 million tons in the first 6 months of this year, 2 percent more than the same period of last year.

Eighty percent of Huabei's 900 oil wells are of the buried hill type, which gives high output at the outset but has a fast depletion rate. Output dropped 40 percent from 17 million tons in 1979 to 10.15 million tons in 1983.

The oil field adopted new computer-controlled methods such as numerical seismic prospecting to verify oil deposits and drill more wells to raise and maintain production levels.

Seventy million tons of oil and 12 billion cubic meters of natural gas deposits were verified in 1984.

Huabei put 100 adjusted wells into operation in the first 6 months of 1985. These have helped regulate output of existing wells and stabilize yield.

Drilling of another 130 oil wells was also completed in the first 6 months of this year. Geological teams are continuing to prospect for oil traps at different strata in the existing oil blocks.

Output from the new wells has now made up for the depletion of the old ones with a small surplus. The oil field expects to produce 10.3 million tons of oil this year.

Three pipelines transmit crude oil from Huabei to Beijing, Shijiazhuang, and Cangzhou. A gas pipeline under construction will provide 400,000 cubic meters of natural gas daily to Beijing residents by the end of this year.

The field's chief geologist said oil output at the Huabei oil field is expected to remain stable for the foreseeable future.

CSO: 4010/165

OIL AND GAS

RICH RESERVES DISCOVERED IN GUDONG OILFIELD

Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 26 Jul 85 p 1

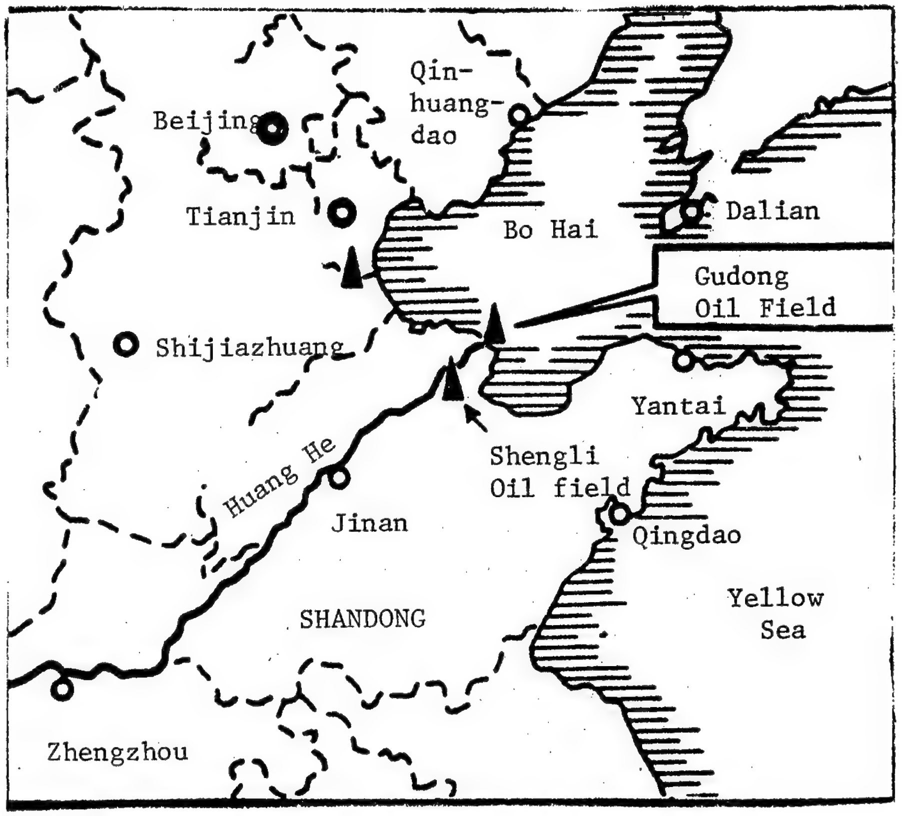
[Article by Zhu Wenzhi [2612 2429 1807]: "Oil Struck in Every One of Gudong's Wells; It is the Largest Oilfield Discovered in China in the Past 10 Years"]

[Text] Zhu Wenke [2612 2429 4430], director of the Shengli Oilfield Headquarters, informed reporters a few days ago that as of 15 July, all 69 wells struck in the Gudong Oilfield produce oil.

Gudong Oilfield is a new oilfield that was discovered in China last year through seismic exploration and drilling and is the 49th section discovered in the more than 20-year history of the Shengli Oilfield. After the Renqui Oilfield in northern China, Gudong is the largest oil producer that has been discovered in China in the past decade.

Gudong is situated on the coast of Bohai Bay where the Huang He empties into the sea, and its eastern section extends into the sea. Gudong currently covers an area of nearly 90 sq km. Not only is this oilfield large in area, but its reserves are concentrated, its geological structure is simple, it has numerous oil-bearing formations, the physical nature of its oil formations is excellent, its crude oil basically contains no sulphur and its oil has good components. The wells have been very accurately drilled, and this has made the oil easy to exploit.

Zhu Wenke said that this year China has plans to build a production capability of 2 million tons at Gudong, and by 1987 will produce approximately 8 million tons. We also will achieve the advanced levels of the 1980s in both development and management. This oilfield is equally significant both for building Shengli into a "second Daqing" (50 million-ton annual output of crude oil) and for the development of China's oil industry. Currently, surveying is being continued in every direction in this oilfield. The ultimate area and oil reserves have yet to be determined.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SHANDONG
Zhengzhou

CSO: 4013/160

OIL AND GAS

DAGANG FIELD YIELDING MORE OIL, GAS

OW141744 Beijing XINHUA in English 1433 GMT 14 Aug 85

[Text] Tianjin, 14 Aug (XINHUA)--Dagang oil field near Tianjin turned out 14.7 million barrels of oil and 340 million cubic meters of gas in the first 7 months of this year, 15 percent and 18 percent more than last year, respectively.

An oilfield official told XINHUA today that the oil increase resulted from further successful geological prospecting in the southern, northern, and central parts of the oil field in the first half of this year.

Sixteen wells drilled in the first 6 months of this year produced a good flow of oil and gas of industrial value in Dagang, which is located on Bohai Bay.

The new discovery of oil-bearing structures in the southern part of the oil field has proved that the oil reserves are linked with each other; high-yielding oil and gas wells, drilled in the shallow layer of the northern part of the oil field have opened up new oil prospects; and prospecting in the old oil field in the central part of Dagang has shown that the enriched oil-and-gas-bearing zones are expanding and possibly link up with offshore oil reserves.

According to the official, the amount of oil reserves verified last year was 50 percent more than in 1983.

The official said that Dagang is importing advanced technology and equipment with 300 million U.S. dollars in foreign loans to further develop the oil and gas resources.

CSO: 4010/165

OIL AND GAS

SHENGLI HAS RECORD OUTPUT IN FIRST 6 MONTHS OF 1985

SK050445 Jinan Shandong Provincial Service in Mandarin 2300 GMT 4 Aug 85

[Excerpts] In the first half of this year, the Shengli oil field well drilling footage reached 2.11 million meters, nearly equal to the total for 1984 and equal to the total in 1982 and 1983. The output of crude oil in 1984 surpassed 20 million tons, while that in the first half of this year reached 13.32 million tons, 2.98 million tons more than the corresponding period of 1984, the previous peak.

Located on the north bank of the place where the Huang He empties into the Bohai Sea, the Gudong prospecting zone is the largest oil and gas field China has discovered in recent years. As of 20 July, more than 70 wells had been sunk, and all of them have hit oil deposits. Among these 70 wells, the one with the highest output has produced 500 tons of oil daily since it went into production.

CSO: 4013/159

OIL AND GAS

SHENGLI MAKES HEADWAY IN SAND CONTROL

OW241231 Beijing XINHUA in English 1154 GMT 24 Aug 85

[Text] Jinan, 24 Aug (XINHUA)--A Shengli oilfield research center, funded by the United Nations Development Program, has developed technology to cut sand content of some oil wells by 90 percent, according to scientists at the center here today.

Shengli, China's second biggest oil producer, had to stop operation of some wells a few years ago because sand content was as high as 0.11 percent.

The oil well sand control technology center has developed machines and technology since 1983 which places gravel in the oil wells to work as a filter.

Application of the new technology to 96 wells has reduced sand content of crude oil to 0.01 percent, meeting the standards of the Ministry of Petroleum.

High sand content of crude oil is a problem in a lot of countries, scientists at the center said. In China, the Liaohe and Dagang oilfields also have serious sand problems which result in wearing out of production equipment and blocking oil tanks and pipes.

Developed countries have studied sand control technology for over 50 years.

In 1982, the United Nations Development Program, China's Ministry of Foreign Economic Relations and Trade and the Ministry of Petroleum signed an agreement to help Shengli oilfield set up the research center.

With U.S.$500,000 granted by the U.N.D.P., the center has imported key laboratory facilities, trained personnel and hired technological consultants. The oilfield invested 5 million yuan to construct the buildings and shops, and to purchase domestic facilities.

CSO: 4010/166

OIL AND GAS

BRIEFS

DAQING RESERVES--Harbin, 30 Jun (XINHUA)--Work has begun on a new oil pool around Daqing Oilfield, China's No. 1 oilfield in northeast China, according to the Daqing Petroleum Administrative Bureau today. The Chaoyanggou oil pool is situated in Zhaozhou, and eastern Zhaodong County in Heilongjiang Province. Reserves have been verified at 120 million tons, one of the biggest oil pools found in recent years. Oilfield officials said that the first production wells will be drilled this year and the annual crude oil production is expected to reach 1.5 million tons. [Text] [Beijing XINHUA in English 0707 GMT 30 Jun 85 OW]

DAQING EXCEEDS QUOTA--Harbin, XINHUA, 3 Jul 85--Daqing has exceeded its production quota for the first 6 months of the year, producing more than 27.41 million tons of crude oil. In all, 27.419 million tons of crude were produced, 145,000 tons more than called for in the original plan. Daqing is China's largest oil field and the 1985 production target is 55 million tons. This will be the biggest year for production in the 25-year production history of the field. It also marks the 10th year since 1976 that crude production has been over 50 million tons. [Text] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 4 Jul 85 p 1]

MORE GAS FOR BEIJING--Beijing, 4 Aug (XINHUA)--The construction of gas pipelines between the North China oilfields and Beijing is basically completed and will supply an additional large number of families in the capital with gas later this year. Beginning May 1984, the gas project is being built in two stages. The first stage, scheduled to be completed by the end of this year, will provide 400,000 cubic meters daily to Beijing, and the second stage, which will go into operation in 1987, will supply 1 million cubic meters of gas a day. The North China oilfields are the country's third largest, with verified reserves of 20 billion cubic meters of gas. Gas pipes are being laid in various residential quarters and industrial areas in Beijing. Upon completion, the 400,000 cubic meters of gas will replace more than 5 million tons of coal presently used for fuel and help reduce air pollution in the capital. [Text] [Beijing XINHUA in English 0207 GMT 4 Aug 85 OW]

NEW SHENGLI GUSHER--Jinan, July 24 (XINHUA)--The 49th section of China's second largest oilfield, Shengli, Shandong Province, is proving to be a rich one. All 69 wells in the Gudong section, sunk in the past year, produce oil, said Shengli officials today. Discovered last year, Gudong is the largest producer to be found in the country in the past decade, following the Renqiu oilfield in Northern China. Situated where the [Huang He] empties into the sea, Gudong covers an area of 90 square kilometers, with its eastern part touching Baohi Bay. The officials said that its oil reserves are quite concentrated and the geological structure is simple. The crude oil contains no sulphur. The Gudong section will have the capacity of producing 14 million bbl at the end of this year and 56 million bbl in 1987, the officials predicted. [Text] [Beijing XINHUA in English 0721 GMT 24 Jul 85 OW]

CENTRAL PLAINS WELL--Zhengzhou, 3 Aug (XINHUA)--The first high-output oil well in the new oilfield on the central China plain is now in production, an official said here today. Since it went into trial operation 14 July, the well has averaged 7,350 bbl of oil and 350,000 cubic meters of natural gas a day, he added. The central China oilfield has abundant oil and natural gas reserves, but all wells drilled previously yielded less than 7,000 bbl a day. [Text] [Beijing XINHUA in English 1315 GMT 3 Aug 85 OW]

CSO: 4010/163

NUCLEAR POWER

USE OF REMOTE SENSING, GEOPHYSICAL PROSPECTING IN NUCLEAR POWER PLANT SITE SELECTION

Beijing WUTAN YU HUATAN [GEOPHYSICAL AND GEOCHEMICAL EXPLORATION] in Chinese Vol 9, No 2, Apr 85 pp 86-91

[Article by Chen Changli [7115 2490 4409] of the Ministry of Geology and Mineral Resources' Bureau of Geophysical and Geochemical Exploration]

[Text] Abstract

Nuclear energy is a safe, clean, and cheap energy source. Nuclear power plant construction should be based on strict geological surveys and technical designs. This article introduces the tasks and requirements of remote sensing and geophysical prospecting work during each stage of nuclear power plant site selection and, based on China's real situation, proposes that remote sensing and geophysical work in each stage of nuclear power plant site selection be organized according to the concepts of systems engineering.

Safety, cleanliness and low cost continually are increasing the competitive position of nuclear power stations among the ranks of new high-power energy resources. By 1983, 25 nations of the world had completed construction of 317 nuclear power plants with a total installed generator capacity of 191,400 MW, equal to 12 percent of total world energy resources. The world also has 209 nuclear power plants under construction with a planned total installed generator capacity of 194,000 MW. Nuclear energy will account for 31 percent of the structure of world energy resources when they are completed.

Nuclear power plant construction is established on the basis of strict geological prospecting and design that focus on the stability of stratigraphic structures and environmental forecasting. International atomic energy organizations have compiled a series of articles on safety to ensure the safe operation of nuclear power plants. The U.S. Nuclear Regulatory Commission has formulated a set of regulatory guidebooks and made clear and strict stipulations concerning the various types of geological prospecting work required during each stage of site selection. The U.S. Geological Survey [?] has compiled a volume of collected articles that interpret the standards based on geological exploration experience at 100 already constructed nuclear power plants. The Ministry of Geology and Mineral Resources convened a discussion meeting of chief engineers concerning remote sensing and geophysical prospecting work as

a part of geological work in nuclear power plant site selection. It introduced foreign articles on related topics and exchanged experiences gained within China. This article offers some general suggestions concerning the tasks and demands of remote sensing and geophysical prospecting work during the different stages of nuclear power plant selection as a reference for my comrades.

I. Remote Sensing and Geophysical Prospecting Work During the Different Stages of Nuclear Power Plant Site Selection

Nuclear power plant site selection in China and abroad has been divided into three stages. Remote sensing and geophysical prospecting work have definite tasks during the site selection and operation stages.

1. The pre-selection stage

Collect 1:500,000 to 1:1,000,000 satellite photographs and regional aeromagnetic and gravity data within a radius of 300 kilometers from nuclear power plants for interpreting regional structures and linear structures and provide information concerning regional fault trace lines. Collect data on natural earthquakes and seismic depth measurements within the region and analyze the seismic activity and deep structures of the region. Make a preliminary evaluation of the regional structural characteristics, regional structural stability and regional environmental geology of a group of candidate sites, eliminate most of them and keep a few to serve as preliminary sites for nuclear power plants.

2. The preliminary selection stage

Collect small-scale remote sensing space images and aeromagnetic and gravitational data for the small number of nuclear power plant sites that were proposed during the pre-selection stage. Make detailed interpretations of regional structures at the pre-selected sites, calculate regional gravitational fields and Mohorovicic discontinuity depth charts, do extrapolative elevational analysis of different aeromagnetic data, integrate data on seismic measurements and chart regional deep faults. Collect historical and instrumental earthquake information and primitive records of major earthquakes, accurately re-determine earthquake epicenters through computer processing during earthquakes and provide precision maps of epicenter locations within a radius of 300 kilometers from the plant site to locate islands of safety.

Develop interpretation of large-scale aerial remote sensing images and interpretation of aeromagnetic and gravitational data for nearby regions (within a radius of 8 kilometers). Develop high-resolution continental and marine seismic reflection surveys and do research on the scale and nature of the major faults and active faults in the nearby region. Especially important is to use remote sensing images and seismic reflection data to determine whether or not the faults cut through the Quarternary system. Study the relief of the bedrock, underground water levels, basement collapse, landslides and mud and rock flows, and other questions.

Use the above data for an Early Site Recommendation Report (ESRR) to provide demonstration data and attachments.

3. The project site selection stage

Develop the necessary remote sensing and geophysical prospecting work for preselected nuclear power plant sites and prepare data and attachments for a Preliminary Safety Analysis Report (PSAR). Work in the following areas should be developed:

1) Collect large-scale aerial remote sensing images and make certain types of remote sensing flights as needed (such as multispectral, colored infrared and color photographs, thermal infrared or side-looking radar, etc.) to compile detailed geological maps and environmental engineering geology maps. Detailed interpretations at the specified breadth and scale should be made for faults that cut through the surface.

2) Develop high-resolution seismic reflection or seismic refraction, drill survey wells and do geophysical prospecting below the wells, and make detailed studies of strata, structures and faults near the plant site and their activities.

3) Develop microseismic monitoring of capable faults and record accurately the locations of micro-earthquakes coming from these strata. Develop constant monitoring of micro-movements and classify small seismic regions. Develop measurement of ground stress and changes in surface features (high-precision benchmarks and distance measurements) or collect these data to investigate fault activity.

4) Measure the minimum age of fault activity. This mainly involves using paleomagnetism and multiple isotopes to determine absolute ages.

5) Develop on-site measurement and laboratory measurement of the parmeters of rock and soil dynamics.

6) Provide project design data on excavation and refill for nuclear power plant construction. Develop shallow strata seismic refraction prospecting.

Submit a Preliminary Safety Analysis Report. Do supplementary work after it has been sent to management departments for inspection and make revisions, and then submit a Final Safety Analaysis Report (FSAR).

4. The construction and operation stage

Apart from the tasks during the three stages of nuclear power plant selection stipulated in the standards, remote sensing and geophysical prospecting also have tasks during nuclear power plant construction and during the operation stage after they are completed.

Remote sensing and geophysical prospecting should be combined as needed for detailed exploration work during the construction stage. Study the underground situation in excavation projects and carry out quality inspection after grouting the cement, undergound water level and water quality monitoring and so on. This mainly involves the use of shallow strata seismic refraction, sound waves and survey wells, and so on.

The operational period after a nuclear power plant is completed requires the establishment of a network of permanent fixed microseismic stations to monitor seismic activity near the nuclear power plant. The intensity of environmental radiation (including the atmosphere, river basins, land masses and the biosphere) should be surveyed before a nuclear power plant is operated to evaluate the effects caused by nuclear power plants. Monitor nuclear radiation in the environment and the surface water and underground water near nuclear power plants as needed. In order to estimate the amount of hot water discharged into rivers, lakes or underground by nuclear power plants and to evaluate the cooling efficiency of cooling towers and cooling tanks as well as thermal losses in nuclear power plants, there should be aerial infrared scanning or measurement of temperatures in shallow underground strata to evaluate the scope and intensity of thermal discharge and the danger of the environment.

Sites suitable for permenent storage of nuclear wastes such as deserts, the ocean, salt domes and salt strata, granite and so on should be surveyed for storage of nuclear wastes. Remote sensing, surface geophysical prospecting and well survey work should be developed.

II. Tasks and Requirements

The tasks and requirements during the three stages of remote sensing and geophysical prospecting work for selection of nuclear power plant sites are:

1. Study the characteristics of strata and structures near and distant from plant sites.

1) Use space remote sensing images to derive interpretive remote sensing geological maps and interpretive remote sensing engineering geology maps (including geomorphologic maps, rock and soil mechanics distribution maps, maps of key hydrogeological features, ectodynamic geological images, etc.). Or, combine with surface geological surveys to provide detailed information on charting components, main features and boundary lines. Or, existing geological maps, structural maps and engineering geology maps can be revised.

2) Collect aeromagnetic and regional gravitational data and use digital processing to provide maps of residual gravitational abnormalities, depth charts of the mohorovicic discontinuity and other features, aeromagnetic abnormality charts, maps with different degrees of analytical interpretation and other maps. Collect seismic depth measurements for studying regions, depths and regional structures.

3) Collect maps of earthquake epicenter distributions. The precision of epicenter location determination on the maps should be investigated. Computers should be used when needed for re-processing to determine epicenter locations. There are different requirements for the precision of epicenter locations for different time period:

a) For recent years, the precision of machine-recorded epicenter locations should be 5 to 10 km.

b) Records since 1950 should have a precision of earthquake epicenter location of 10 to 20 km.

c) Records since 1930 should have a precision of earthquake epicenter location of 20 to 30 km.

d) For records before 1930, use only those with a precision of 30 kilometers or less at the time.

4) Based on space remote sensing images at different scales, interpret primary factors of environmental engineering geology, especially landslips and mud and rock flows, surface collapse, ancient river beds and so on for verification through surface inspections. Use surface geophysical prospecting methods to determine the nature of landslips and the degree and scale of collapse near the plant site.

5) Use high-resolution shallow strata seismic reflection, shallow strata seismic refraction, sound waves and in-well perspectives to determine the depth and relief of the basement rock surface, the thickness of the Quaternary cap, faults beneath the Quaternary cap, the geological structure of the basement rock and soft interbedded strata, possible karst caves in the basement rock, and so on.

6) Use seismic methods and well measurements to determine the structure of Quaternary sediments (velocity differentials), water-bearing strata, water table, the thickness of the weathered surface of the basement rock, the degree of weathering, underground water discharge points in fissures, density of fissures and so on.

2. Study faults.

One very important and serious task in geological work for nuclear power plant site selection is to investigate faults far afield and nearby, as well as close to the plant site. The scale for investigating faults is related to the distance between the fault and the plant site. The distances required for investigating faults of differing lengths are shown in Table 1.

Table 1. Distance between Faults and Plant Sites and Range that Should Be Investigated

Distance between fault and plant site in miles (kilometers)	Shortest fault that should be investigated in miles (kilometers)
0 - 20 (32)	1 (1.6)
21 - 50 (80)	5 (8.0)
51 - 100 (32)	10 (16.0)
101 - 150 (240)	20 (32)
151 - 200 (320)	40 (64)

Faults that have the following direct or indirect indications on remote sensing images and geophysical charts should be investigated for research and verification:

1) Faults reflected as geological phenomena on remote sensing images.

Contact between geological materials with different qualities, loss or repetition of strata, or truncation of strata and structures.

2) Faults reflected as geomorphological components on remote sensing images.

Discontinuities of levels in water systems, subsidence lakes or a linear distribution of depressions, a series of springs or volcanoes, hot springs, ground fracture lines, cliffs or triangular surfaces along mountain ridges, inclined terraces or large changes along ocean coastlines, abnormal inclines or slopes, large differences in vegetation of colors on images.

3) Reflections of faults on geophysical planar maps or profile maps.

a) Belts of dense inclined or linear gravitational or magnetic contours, seismic wave velocity abnormalities, discontinuities in seismic reflection strata, discontinuities in comparative positions of strata in bore-hole well measurement profiles, a linear distribution of natural earthquake epicenters, or a planar distribution of earthquake origins.

3. Study fault activity.

Research on fault activity is a key topic for evaluating nuclear power plant site selection. The determination of whether each fault is active or not is extremely important and the work should be done seriously and strictly.

1) The definition of capable faults: Faults where at least one instance of activity has occurred at or near the surface within the past 35,000 years, or where there has been repeated activity over the past 500,000 years.

2) Indicators of fault activity: There are many geological indicators and data for determining fault activity. The indicators provided by remote sensing and geophysical prospecting data include:

a) Contact between Quaternary sediments and older strata that form faults on remote sensing images indicates that the fault cuts through Quaternary sedimentary strata.

b) An indication of a fault in Quaternary sediments on seismic reflection profile charts.

c) A linear arrangement of earthquake epicenters or a linear distribution or clustering of microseismic epicenters in microseismic record collection after more precise locational determinations.

d) An obvious vertical rise in the crust or changes in levels during high-precision bench mark and distance measurements between fixed points.

3) Based on the definition of capable faults, use paleomagnetic and various isotopic methods to measure the minimum age of the fault's activity. The method and scope of their utilization are:

a) The C-14 method, which is suitable for use in faults that are filled with calcium material and for measurements within a range of 40,000 years.

b) The racemic method based on alkalinity or acidity, which is effective for organic matter and has a measurement range of 5,000 to 35,000 years.

c) The U-Th (uranium-thorium) method, which is suited for the filler in calcite veins. It has a measurement range of 81,000 to 170,000 years and a maximum of 300,000 years.

d) The K-Ar (potassium-argon) method, which is suited to volcanic rock and magmatic rock and has a rather broad measurement range of about 1 million years.

e) The Rb-Sr (rubidium-strontium) method, which has a measurement range of 80 million years.

f) The atomic fission track method, which is temperature-sensitive and can be used for measurements of 1 million years.

g) The thermal luminescence method, which is suitable for limestone and dolomite, and has a measurement range of 25,000 years.

h) The liquid impurity method, which is a pressure and temperature method that can be used to measure the minimum age of crystallized material that fills faults.

i) The palemagnetic method, which is suitable for use in rock veins or sediments that displace or extend beyond the strata. The range of age measurement is rather wide, but it cannot be used after the late Quaternary.

4) There is a broad range of remote sensing and geophysical prospecting work for examination of faults that break the surface. Detailed work must be done if an active fault or one that cuts through to the surface is discovered. The breadth of the work region is related to the size of the area controlled by the fault and the level of earthquakes that have occurred. The stipulations are:

a) The area of the investigation should be identical to the area controlled by the fault for earthquakes at a scale of less than 5.5.

b) The area of the investigation should be twice that of the area controlled by the fault for earthquakes at a scale of 5.5 to 6.4.

c) The area of the investigation should be three times that of the area controlled by the fault for earthquakes at a scale of 6.5 to 7.5.

d) The area of the investigation should be four times that of the area controlled by the fault for earthquakes at a scale of 7.5 or greater.

III. Parameters

The use of geophysical prospecting methods to determine parameters of soil and rock mechanics is an important basis for project design. The main parameters are:

$$G = \rho V_s^2$$

$$\sigma = \left[1 - 2\left(\frac{V_s}{V_p}\right)^2\right] \Big/ \left[2 - 2\left(\frac{V_s}{V_p}\right)^2\right]$$

$$E = 2G(1+\sigma)$$

In the formula, V_s= wave velocity of horizontal waves (shear), V_p= wave velocity of vertical waves (compression), p = density, G = shear modulus, σ = Poisson ratio, E = Young's modulus.

1. Use seismic and sound wave measurements to evaluate rock and soil mechanics and qualities.

1) Measure the injection coefficient N in soil, which has a very good interrelationship with V_p and V_s. The linear equation for N--V_s is:

$$\log V_s = 91.0 - 0.337 \log N$$

2) The ultimate compressive strength of soil and rock:

$$q = aV_p^2$$

The compressive strength is $R_c = aV_p^2 + bV_p + C$ and is used to evaluate the integrity of rock.

3) The experiential relationship between dynamic and static elasticity moduli is:

$$E_s = 0.01Ed^2$$

4) The rock quality division (RQD index) is shown in Table 2).

Table 2. Rock Quality Categories

Rock quality grade	RQD Index	V_p (km/sec)	Velocity ratio $(V_b / V_p)^2$
Extremely bad	0 - 25	1.0 - 2.0	0.0 - 0.2
Bad	25 - 50	2.0 - 3.0	0.2 - 0.35
Acceptable	50 - 75	3.0 - 4.0	0.35 - 0.6
Good	75 - 90	4.0 - 5.0	0.6 - 0.8
Extremely good	90 - 100	> 5.0	0.8 - 1

2. Calculate a permissible parameter for horizontal acceleration.

The permissible value of horizontal surface acceleration to determine the grade and intensity of earthquakes near nuclear power plants under the mechanical conditions of the plant site is an important index for nuclear power plant construction. The U.S. stipulates the level at 0.10 g for 90 nuclear power plants and at 0.20 to 0.25 g for 5 plants. China allows 0.1 g at the present time.

The use of trans-hole normal seismic locations to measure shear wave velocity in the rock and soil between two wells is a key item of work. Formulate a mechanics model for the plant site based on the measured value V and input the time--history of the maximum earthquake. The output horizontal acceleration value is less than 0.1 g.

3. Liquefaction

Seismic shear causes liquefaction of water-bearing friable sediments. During design, assume that 0.35 g occurs at the surface (the conservative value is 0.5 g). The duration and degree of shear determine whether or not water-bearing friable sediments liquify, and it also reflects the normal position situation of ultimate pressure and nature of the dielectric. The measurement ratio is:

$$\frac{\text{Indoor measurement of the periodic coefficient when determining the shear pressure value}}{\text{Periodic coefficient observed for an identical shear pressure value during the during the process of normal position input shear pressure}}$$

The critical value of the safety coefficient is when the ratio is less than 1. Liquifation is possible when it is less than 1. The conservative requires that the ratio reach 1.50.

4. Tracer experiments.

Isotope tracing technologies should be used to measure diffusion rates and distribution coefficients for studying environmental pollution from the infiltration of nuclear materials spilled from nuclear power plants into the underground water.

1) The diffusion rate (dimensional length) refers to the degree to which the diffusion of nuclear material causes the concentration of nuclear material to fall below the maximum permissible concentration (MPC). This generally involves using the isotopic solution observed in the wells to measure the solution concentration (radiation intensity) in the solution from inside the well at different times.

2) The distribution coefficient is the ratio between the amount of pollutants absorbed in the structure of water-bearing strata and the residual amount in underground water. The reduction in pollutant concentrations caused by absorption will reduce the level below the maximum permissilbe concentration (MPC).

IV. Some Proposals

It can be seen from the above work tasks that remote sensing and geophysical prospecting are widely used and play an important role throughout the various stages of nuclear power plant site selection up to the construction and operations stage. Nuclear power plant construction is a comprehensive embodiment of modern scientific and technical levels. Geological and geophysical work for nuclear power plant selection also should reflect modern technical levels and meet the needs of nuclear power plant construction. For this purpose, I propose that:

1. The concepts of systems engineering should be used to organize remote sensing and geophysical prospecting work during each stage of nuclear power plant site selection, and they should be integrated organically into the overall design of geological work as a whole. The concepts of systems engineering require that the sciences used in each method be organized organically to correspond to different stages and that they provide optimum programs to avoid a loss of coordination and mutual detachment within each of the methods.

2. The fact that prospecting work must be complete and serious and the many types of methods requires coordination of levels. Often this cannot be undertaken entirely by the technical staff of a single unit. For this reason, primary specialized personnel should be involved in comprehensive design and organize mutual coordination of all types of work.

12539
CSO: 4008/362

NUCLEAR POWER

OPINIONS ON NUCLEAR WASTE MANAGEMENT EXPRESSED

Beijing HE KEXUE YU GONGCHENG [CHINESE JOURNAL OF NUCLEAR SCIENCE AND ENGINEERING] in Chinese Vol 5, No 1, Mar 85 pp 78-82

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[Text]

Abstract: In order to manage well radwastes from nuclear power plants the following four basic principles should be followed: 1) to strive to decrease the radwastes; 2) to strive to develop the volume reduction technology; 3) to develop a proper solidification technology; and 4) to realize final disposal which guarantees safety. These points are discussed in this paper.

Nuclear power plants release a great amount of waste gas, liquid, and solid in their operation process. Gaseous and liquid wastes may be released to the environment or recycled after they are purified to the acceptable standard. The amount of radioactive wastes depends on the type of the reactor, the power rating, design, operation, management, and maintenance of the power station, the nature of the incidence, and the waste processing technique. Different power plants produce widely different amounts of wastes, a 1000 MWe pressurized-water reactor [PWR] power plant generates 300-1000 m^3/yr of wastes. Assuming a power plant has 40 years of operating life and taking into account the wastes generated after its retirement, a 1000 MWe PWR power plant produces a total of 20,000-50,000 low and intermediate level radioactive solid wastes, a substantial amount indeed.

Nuclear power is one of China's high-priority energy sources for development. By the end of this century China is expected to have 10,000 MWe of nuclear power plants in operation. Assuming 2000 MWe of power plants are built in 1990 and 2000 MWe are built every 2 years therafter, then China can expect an accumulation of 36,000 m^3 of low and intermediate level radioactive solid wastes by the year 2000. If 1 m^3 of solidified waste fills one barrel, there would be 36,000 barrels (200 liters per barrel) requiring 72 storage chambers, each holding 5000 barrels and measuring 64x12x8m. If these wastes are buried in shallow strata with a stacking height of 4m, it would require 0.9 hectares of land. Most of China's nuclear power plants will be built in eastern,

central south, and northeastern China where electric power is in short supply. Since these are areas with well-developed industrial and agricultural production and have a high population density and land economic value, it is of utmost importance that radioactive wastes be handled safely and economically so that nuclear power may be further developed and the public health and the environment may be protected. To manage the radwastes from nuclear power plants, four basic principles must be followed:

1. Decrease the Generation of Low and Intermediate Level Radioactive Wastes

The low and intermediate level radioactive wastes are the pollution sources of the nuclear power industry. The strategy for handling such wastes should be a combination of prevention and treatment. Today, both the countries with developed nuclear power and the countries with developing nuclear power industry are paying great attention to the reduction of radwastes, taking it to be a high priority task in the management of waste gas, waste liquid and solid waste. Actions are taken in the design, construction and operation of the nuclear power plants and in the handling of the wastes.

In the selection of an engineering process, a process that produces less waste and favors waste handling is considered an advanced, rational, and economic process. The reactor structure and equipment should be made of high-quality, corosion-resistent materials that are easy to clean in order to improve the service life and reliability of the equipment and reduce the amount of maintenance and replacement necessary. The water quality of the coolant and the purity of the additives should be controlled and the generation of activated products should be kept to a minimum. The quality of irradiated components must be assured because component damage is a main source for radioactive fission products. Foreign power plants pay great attention to component quality and the actual damage ratio is only 0.01-0.02 percent.

Practical experiences have shown that the amount of wastes generated depends on the level of management. We need to strengthen the management, formulate sound and practical regulations, train and evaluate the operators, and educate all the workers so that they understand the importance of reducing radioactive wastes. Ideally a special task group should be formed to periodically examine the problems existing in waste management.

The waste gas from a nuclear power plant is usually catalytically hydrogenated, dried, compressed, and stored for about 60 days and then filtered by a high efficiency filter before being released into the atmosphere. The plant atmosphere may be released after going through activated charcoal and high efficiency filters. The waste water from a nuclear power plant, depending on the salt content, is treated with ion exchange, evaporation, and filtering. We should strive to improve the purification efficiency of waste gas and waste water treatment and recycle in order to reduce secondary wastes. Wastes should be collected and stored according to category to avoid cross-contamination. Ordinary refuse should be handled as such and we should never treat all the wastes from a nuclear power plant as radioactive wastes.

Contaminated equipment or components may be cleaned and reused, or treated as nonradioactive waste to reduce the volume of wastes. Common cleaning methods include chemical, ultrasonic, high-pressure water or steam jet, and electrolytic cleaning.[1] Improper use of detergents often produces many secondary wastes which are difficult to handle because of their strong corrosive nature. China has studied cleaning methods for a long time and has accumulated considerable experience, but there still remain a number of problems. To meet the needs of the nuclear power plants, we need to develop efficient detergent and cleaning methods in order to conduct decontamination without shutting down the reactor and to clean the evaporators, pumps and valves. Decontamination standards and codes are essential.

In addition, efforts should be spent to develop or import and apply general-purpose, sensitive, fast, and convenient monitors, especially the continuous monitors and controls for waste gas and liquid.

2. Develop Volume Reduction Technology

The volume of radioactive wastes already generated should be reduced as much as possible. Various volume reduction techniques should be developed in a major effort. Since 40-60 percent of the solid wastes produced by a nuclear power plant are combustible, burning can reduce the volume by 20-60 times. After burning, more than 70 percent of the radioactive elements are in the ash, which can then be compacted for final disposal. The radioactive waste incinerator should have safe and reliable waste loading and ash unloading systems and a high efficiency tail gas purification system. The design standards are stringent and the construction and operating costs are high. Generally speaking, it is not economical to install an incinerator for a single nuclear reactor; however, a common incinerator for a multireactor nuclear power plant or concentrated regional nuclear facilities is also effective and economical. Foreign nuclear power plants are currently developing incineration facilities. China has taken some preliminary steps in the design, construction, and operation of radwaste incinerators and efforts should be organized on this basis to design and build such facilities.

Although the volume reduction achieved by compaction (2-8 times) is not as large as that by incineration, the compaction apparatus is easier to operate and costs less to build and operate. An incinerator costs several million to 10 million yuan whereas a compaction facility costs only several tens or hundreds of thousand yuan. Compaction is therefore a low-cost alternative for volume reduction and is used widely in foreign power plants. Usually, 20-30-ton presses are used to compact the waste directly into the storage barrel or into blocks before loading into the barrel. Mobile compaction devices transported by truck have been built in West Germany to compress wastes into 15-30 cm thick disks for loading into 200-liter storage barrels.[2] Large-scale presses have also been used to compact the waste along with the barrel. The 400-ton press in Manche, France, compacts the storage barrel to reduce the volume even further. Ordinary presses may be easily converted to handle radwastes by installing suitable safety features.

The scrapped contaminated equipment or parts often have a large volume and may be compressed, crushed, or cut into small pieces to reduce their volume. The cutting and dismemberment technology is particularly important for the handling of large quantities of retired nuclear facilities and wastes. Parts taken from the nuclear reactor such as pipes and control rods are often highly radioactive and techniques for underwater demolition and cutting, plasma arc cutting, laser cutting, and electric arc sawing are therefore quite important. The research and development of such technology is still very weak in China.

3. Develop Solidification Technology

Most of the radioactive elements in radwastes would have decayed to a harmless level after a short period of storage, the remaining species -- Cs^{137}, Cs^{134}, Co^{60} and Sr^{90} -- would still have a radioactive level 10^3-10^6 times higher than the acceptable release level. The radwastes from a nuclear power plant should therefore be stored for 300-600 years. People have designed a multitude of shields to separate such radwastes from the human living environment. The first shield of protection is to solidify the radioactive wastes in a stable solid. The evaporation residue, waste resin, filter slush and incinerator ash are either high in moisture content or loose in form and tend to pollute the environment. They are also hard to transport, store, or handle and must be first solidified. The ideal solidification method should be safe and economical. The process itself should be safe and the solidified product should be safe to store. The release rate of radioactive elements should be low, the mechanical strength should be high and the thermal stability and radiation stability should be good. To be economical the waste content should be high and the equipment investment and operating costs should be low. The combined cost for solidification, transport, storage, and handling should be kept low to minimize capital outlay. Solification techniques already developed for low and intermediate radiation level wastes include cement solidification, bitumen solidification, and plastic solidification. Each has its own merits and shortcomings and each applies to certain types of wastes.[3]

The oldest and most commonly used method is cement solidification because its operation is simple and safe. However, it has two major drawbacks: 1) the waste content is low and hence the volume is large; and 2) the seepage rate of radioactive elements (such as Cs^{137}) is high. A number of methods have been developed to reduce the seepage rate, among them: 1) pretreat the waste liquid and precipitate out cesium with potassium ferrocyanide and remove cobalt with activated carbon; 2) mix in additives such as zeolite, rock, or bentonite; 3) cost the solidified cement with bitumen, polystyrene, or silicon tetrafluoride; and 4) use hot or cold solidification to increase the density. These methods may reduce the seepage rate considerably but also increase the volume and complicate the operation. Waste liquids may be turned into a dry power by evaporation before solidification to reduce the volume. In the hydraulic fissure method, the radioactive waste liquid, concrete grout and additive are injected into waterproof shale rock. This method places the waste directly into its storage location and is a viable method when the appropriate shale strata are available.

The waste content in bitumen solidification is 2-3 times higher than the cement solidification and the seepage rate is 1-2 orders of magnitude lower. The bitumen solidification method was used in the early 1960's in some European countries (Belgium, France, and West Germany). In mid-1970's there was some heated controversy over the safety of bitumen solidification. China also studied the safety of bitumen solidification and found that temperature control is crucial[4] and the temperature should be kept below 200°C. The sodium nitrate content of nuclear power plant wastes is low and experience shows that bitumen solidification can be safe as long as precautions and proper operating procedures are observed.

Plastic solidification is a relatively new technique. The first plastic solidification method uses urea-formaldehyde but the technique has been gradually phased out[5] because it produces acidic corrosive water in the solidification process. A number of new plastics are being developed including polystyrene, polyethylene, polyvinyl chloride, polyester, and epoxy. The advantages of plastic solidification are the high content of waste and the low seepage rate. For example, 100 m^3 of sodium sulfate waste liquid (10 g/l) produces 4 m^3 of residual liquid (250 g/l) after evaporation process. Using the cement solidification method, 40 barrels (200 l/barrel) of solidified waste weighing 22 tons will be produced. Using plastic solidification, only 7 barrels of solidified waste with a total weight of 2 tons will be produced[6], greatly reducing the need for transportation, storage, and burial space. Furthermore, wastes not suitable for cement solidification such as waste resin and TBP solvent may be satisfactorily solidified in plastic.[7] Because of this, plastic solidification has been developed fairly quickly in recent years.

Some countries today have switched to solidification methods with a high volume reduction ratio[8] because of shortage in storage site (like Japan) or increases in the cost of waste processing (like the U.S.). China has not fully developed its solidification technology, cement solidification of concentrated wastes and filter grout and polyethylene solidification of waste resin are viable approaches. We should conduct engineering tests of cement solidification of borate wastes and improve the solidification method, and we should also develop high content salt powder solidification and granular solidification.

Solidification apparatus transportable on trucks[9] have been developed in foreign countries in recent years. Since such equipment may be transported to the location of waste processing, the utilization is high and the economic benefits are great. It is an economical, rational and effective methods in regions where nuclear power stations and nuclear facilities are scattered.

4. Achieve Safe Final Disposal

Generally nuclear power stations are not equipped to handle the final disposal of radioactive solid wastes. Such solid wastes are usually stored in the temporary storage of the power plant for 5-10 years and then delivered to the final disposal site. Today nuclear power plants in other countries use three disposal methods: burial in shallow strata, storage in mines or rock caves, and disposal in the ocean.

Ocean disposal requires the most elaborate packaging and has the highest cost, and it has also met increasingly strong objections. A decision was made in the London meeting in February 1983 to temporarily halt disposal of radioactive wastes in the ocean.

Storage in abandoned mineshafts and in rock caves is safe but cost more than burial in shallow strata. A typical example of storage in an abandoned mineshaft is the salt mine at Asse in West Germany, where 140,000 barrels of low-grade radioactive waste and 1,3000 barrels of intermediate grade waste were stored. In addition to salt mines, there are also plans to store nuclear waste in iron mines, uranium mines, gypsum mines, and limestone mines. Sweden and Switzerland are also studying the installation of nuclear waste storage facilities in rock caves.[10,11]

Burial in shallow strata is easy to implement at low cost and is most often used. The types of structures used include ditches, wells, underground cellars, and surface mounds. Ditches of various sizes are used most often, the typical dimensions are 30-240 m long, 10-15 m wide and 6-10 m deep, and they are constructed of concrete. Waste with a high level of radioactivity such as waste resin and used filter elements is best stored in wells. There are different types of wastes of different radioactive levels. Water is the most likely medium to transport the radioactive elements and the control of ground water and surface water is therefore very important. The surrounding soil should be able to adsorb, exchange, and retain the radioactive material and prevent it from migrating. The site selection requires detailed geological and hydrological survey and environmental impact and safety factors are considered. Measures must be taken in the construction of such storage facilities to prevent ground water and surface from entering the storage zone. After the disposal site is closed, it should be monitored and maintained for a long period of time to prevent the exposure of the radioactive material caused by soil and water loss and weathering erosion. The long experience of shallow strata burial gained by the United States, France, the United Kingdom, Canada, and the Soviet Union has shown that, as long as the burial sites are properly chosen and carefully managed, the radioactive waste can be separated from the living environment of human beings for 500-600 years.

At the present time China is considering building nuclear power plants in the eastern coastal area. This is a humid and rainy area and metallic storage barrels may corode if they are left in temporary storage sites for a long time. We should begin coordinating and planning the storage and disposal tasks and build the necessary structures at an early date to avoid future problems.

Based on the experience accumulated by foreign countries and the actual situation in China, we should employ the shallow burial method and storage in abandoned mines and rock caves as local circumstances permit. Because of the large size of China, a centralized disposal scheme would require long-distance transportation of the nuclear waste and would lead to additional costs and safety concerns. We should therefore construct local disposal sites and do so based on a rational scheme. We suggest that hydrological and geological surveys be conducted first in eastern China and in the central south region

and next in the northeast or Nei Monggol and a number of candidate sites be chosen for environmental impact studies. The selection of the disposal sites should be finalized after sufficient comparison and investigation. Three disposal sites of the size of the Manche disposal site in France should be built in the above three regions. (The Manche disposal field has a volume of 400,000 m^3, occupies 12 hectares of land and cost 150 million Francs, equivalent to 30 million yuan). These three disposal sites are expected to satisfy the nuclear waste disposal needs for nuclear power plants and radioactive wastes generated by isotopes and nuclear technology applications to the year 2020.

In order to base our site selection, design, construction and operation of nuclear disposal facilities on scientific, rational, and safe and reliable grounds, we should organize an effort to formulate standards, codes, and regulations and at the same time develop the necessary scientific research.

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CSO: 4008/372

SUPPLEMENTAL SOURCES

SOLAR, WIND ENERGY DEVELOPED IN QINGHAI

OW200832 Beijing XINHUA in English 0642 GMT 20 Aug 85

[Text] Xining, 20 Aug (XINHUA)--Solar energy stoves and wind power generating units are used for cooking and light by more than 20,000 peasant and herdsmen families in Qinghai Province in northwest China, according to local officials.

Farmers and herdsmen in the province in the past depended on animal droppings for cooking fuel and oil for light. About 36 percent of the peasant households did not have enough fuel for cooking.

The provincial government has paid great attention in recent years to developing solar and wind energy in the highland area which has an average of 3,000 hours of sunshine a year and consistent winds.

More than 10,000 solar energy stoves and 15,000 wind-powered generating units have been built in the province's agricultural and pastoral areas. In addition, the province has installed 68 solar heaters and 15 solar houses.

The province has established research institutes and development corporations to speed up this development.

More energy has enabled herdsmen families scattered on the grasslands to enjoy tape-recorders and tv sets. Of the 75 households around Qinghai Lake that have installed wind generating units, 30 use them to run tv sets.

CSO: 4010/166

SUPPLEMENTAL SOURCES

BRIEFS

WIND POWER TESTED--In the past 3 years, China's wind powered electricity has developed from the experimental stage to the test stage. China has already installed more than 10,300 wind generators with a total capacity of 1,484 kilowatts. The use of these wind generators has provided experience in promoting wind powered electricity for those regions with sparse populations, vast territory, plenty of wind and no power. For more than 30 years, China's rural areas have supplied energy through conventional energy sources and through large or small power networks, and this has solved the energy used in the production and livelihood of more than 500 million peasants. Currently, places that do not use electricity are mainly in sparsely populated areas in the grasslands, in mountainous regions, forests, fishing areas and islands. Using wind power in these areas which have wind but no electricity is an economically feasible method. At the present time, industrial departments have already started batch production of small 50-kilowatt and 100-kilowatt wind generators. In these times of high costs, high cost of energy per kWh, few standardized types, low quality and other drawbacks, the concerned administrative, scientific research and production departments are also thinking of ways to solve these problems. [Text] [Beijing NONGMIN RIBAO in Chinese 20 Jul 85 p 1]

CSO: 4013/164

CONSERVATION

OFFICIAL URGES EVEN GREATER EFFORTS TO SAVE ENERGY

OW291317 Beijing XINHUA Domestic Service in Chinese 1216 GMT 26 Aug 85

[Text] Beijing, 26 Aug (XINHUA)--According to estimates by departments concerned, energy conserved by the country in the first 6 months of this year amounted to 20 million tons of standard coal, equivalent to two-thirds of that conserved last year. In an interview with a XINHUA reporter today, a responsible person of the State Economic Commission said that this achievement has been made primarily by strengthening energy management, readjusting the industrial structure and product mix, and carrying out energy-saving technical transformation under the impetus of reform.

The responsible person said: Spurred by reform since the beginning of this year, many enterprises have strengthened energy management to invigorate the enterprises. A number of enterprises have instituted a reward and penalty system for energy conservation by linking the conservation quota with the economic responsibility, thereby firing the enthusiasm in all quarters for saving energy. As a result of carrying out energy-saving technical transformation projects, old equipment that consumed more energy has been upgraded and technological process improved.

The responsible person said: The country's energy consumption in ratio to output value in the first 6 months of this year lowered by 7.3 percent over the same period last year. This figure was rarely seen in recent years. Thanks to the efforts to readjust industrial structure and product mix and develop electronics, light, and other industries that consume less energy as well as high-grade durable consumer goods, energy equivalent to over 12 million standard coal was conserved. According to sample checks by departments concerned, energy consumption for 15 major energy-consuming steel, chemical, petroleum, electric engineering, and nonferrous products was less than that in the same period last year. As a result of lowering energy consumption of these products, 3.5 million tons of standard coal were saved in the first 6 months of this year.

The responsib le person emphatically pointed out: In spite of the remarkable achievement, it is necessary to keep a clear head as far as energy conservation is concerned. There is still a great potential for energy conservation because the portion of energy conserved as a result of technological progress in the first 6 months of this year is relatively small. Therefore, greater attention should be paid to the role of technology in energy conservation. He called for efforts for this work in the following three fields: 1) leaders at various levels should pay close attention to energy conservation, assign a relevant department and special personnel to take charge of the work and establish the responsibility system; 2) it is necessary to persistently carry out reform, strengthen management, and break the practice of "everyone eatint from the same big pot" in energy consumption; and 3) it is necessary to continue to carry out technical transformation and speed up the process of ridding equipment that consumes more energy.

CSO: 4013/173

CONSERVATION

REPLACING OIL WITH COAL SPELLS BIG ENERGY SAVINGS

OW090904 Beijing XINHUA in English 0850 GMT 9 Aug 85

[Text] Beijing, 9 Aug (XINHUA)--The strategy of replacing oil with coal saved China more than 26 million tons (182 million bbl) of various types of fuel oil from the second half of 1981 to the first half of this year, ECONOMIC DAILY reported today.

The State Council made the plan in 1981 in a bid to reform the fuel structure and to boost exports of oil. About 40 million tons of fuel oil were burned in 1980.

The main items of the plan include the building of coal-fired power plants and industrial furnaces to save fuel oil.

CSO: 4010/164

COMMERCIAL VIABILITY OF SOUTH CHINA SEA STRIKES DIMMING

HK010247 Hong Kong SOUTH CHINA MORNING POST (BUSINESS NEWS SUPPLEMENT) in English 1 Aug 85 p 5

[Article by Olivia Sin]

[Text] Esso China plans to conduct further studies to evaluate the commercial viability of its marginal oil find in the South China Sea.

Informed sources told BUSINESS NEWS that the structure in which Esso struck oil is complicated and needs detailed assessment.

It appears Esso is facing the dilemma of whether to abandon the discovery well or invest a substantial sum on a medium-to-small-sized oil field.

If Esso proceeds with the development, it will be the second marginal field in the South China Sea after that being worked by the French firm Total Chine.

Esso's Wenchang 19-1-2 discovery well in block 40/01 in the Pearl River Basin reported a flow of 3,200 barrels per day (bpd).

The sources said Esso China, an affiliate of the Exxon energy group responsible for exploration activities in China, has already shot an expensive three-dimensional (3D) survey on the structure.

The next step, they said, is to carry out appraisal drilling to obtain more information about the size of the oil reservoir and thus determine its viability.

"Esso's seismic surveys indicate that it is not a major reservoir," the sources said, adding that the discovery has only "marginal prospects."

They pointed out that the cost of development will be high because the oil is situated in deep water and long pipelines will be needed.

Total Chine's appraisal program in the Beibu Gulf will start producing oil by June. More than U.S.$200 million will be needed to develop the "marginal" field, which is estimated to produce 700,000 tons of oil a year.

Esso is one of three companies which have struck oil in the South China Sea under first-round exploration contracts. The others are the Agip-Chevron-Texaco consortium and Phillips Petroleum Co.

Meanwhile, Esso China will soon complete its drilling commitment as required in the first stage of exploration (lasting 3 years), which will expire next year.

It is believed the company has so far sunk eight wells in its two contract areas in the South China Sea. Five are in the 40/01 block and three are in the 04/27 block.

Esso is drilling its ninth well (in block 04/27) and the work is expected to be completed by the end of this month.

Sources said this last well does not look promising.

On completion of its ninth well, Esso will suspend operations for about 6 months to conduct an overall evaluation.

The company will probably resume work in March by embarking on the appraisal drilling program.

Esso will then discuss with its partners, Shell Co and Nanhai West Oil Corp, whether to develop the Wenchang structure.

In the meantime, Esso is to reduce its staff in Guangzhou by posting some of them to new assignments.

The scale of Esso China's future activities in China will depend on three factors:

--Whether it will enter into the second and third stages of exploration on the two blocks granted in the first round of offshore bidding.

--Whether it will obtain new acreage in the second round bidding, the results of which are expected to be announced around the end of the year.

--Whether it will seek new exploration areas in China's onshore oilfields.

If Esso opts for development in China, the work will be undertaken by Esso Eastern, the company specializing in production activities.

Among the 10 oil operators in the South China Sea, Esso China is the third to have completed its work commitment in the first stage of exploration specified under the first round.

A Chinese oil official had earlier said that Idemitsu and Pennzoil have also fulfilled their drilling commitments.